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let Halley Flyby Mission

mission to Halley should be designed to maximize the e in terms of the objectives of the comet exploration m set down by the NASA Comet Science Working and the Space Science Board (Report of the Come! e Working Group, NASA TM 80543, 1979; Strategy Exploration of Primitive Solar System Bodies-Asiaromets, and Meteoroids: 1980-1990, Committee on 1ry and Lunar Exploration, Space Science Board, giton, DC, 1980). In order of priority, these objectives

a letermine the chemical nature and physical structure fru nuclei and to characterize the changes that occur as of time and orbital position;

haracterize the chemical and physical nature of the teleres and lonospheres of cornets, as well as the prodrhat occur in them, and to characterize the developill he atmospheres and ionospheres as functions of n orbital position; and

n letermine the nature of comet talls and of the prois) which they are formed and to characterize the in-(In of comets with the solar wind. if rarticular context of a Halley mission, these can

q il as follows: etermine the appearance of the nucleus of Comet Infer (a) size and shape, (b) structure, (c) hetero-

termine the chemical composition and physical hoth the and nonvolatile material emitted by

racterize the processes that occur in bright, active as Halley and new comets), including (a) chemical. and plasma processes in the atmosphere and iono-(b) dynamics of dust and ice grains; (c) interaction the solar wind and the coma; and (d) structure and . of the tails,



ANSACTIONS, AMERICAN GEOPHYSICAL UNION

Piori A. F. Spilheus, Jr.; Associate Editors: Claude J. Allegre, Peter M. Kevin C. Burke, Krisiina Katsaros, Gerard Lachapelle, Christopher T. sell, Richard A. Smith, Sean C. Solomon, Carl Kissiinger; News Writer: Jara T. Shore; EOS Production Staff: Sandra R. Marks, editors assist-F": Qarrison, copy editor; Dae Sung Kim, senior layout artist; Patricis and Margaret W. Consiley, layout artists.

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aing that meets AGU standards is accepted. Contact Eileen O. Simms,

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Cover. This image of the terrain of the conterminous United ım from about 550.000 verage elevation points provided by the U.S. Department of Deonse. A contour interval of 121 m was used between 15- and 500-m levation, and one of 619 m above that elevation. The outline of the onterminous United States is not pracise because the contours bein at an altitude of 15 m.

Well-known geologic features like the Mississippi Embayment, the Snake River Plain, the Basin and Range, and various mountain anges are readily recognizable. Of perhaps greater interest are leatures and characteristics not previously recognized or reported in the literature. For example, an arcuate zone that includes Lakes Ontario and Erie extends from the St. Lawrence Valley to the west border of Michigan, it corresponds approximately to part of a predicted zone of brittle deformation caused by the Pielstocene ice load. The highlands of the western United States exhibit a blocklike outline to the north and east, being delimited by a boundary extending from south cen-tral Texas to northeast lows and thence west to the Olympic Peninsula of Washington. The east boundary is the dividing line between typical seatern and western topographic expression; it is also the approximate location of selemicity associated with the Nemaha Up-lift. The central and southern Appalachians show a surprisingly angular outline, particularly in contrast to the Appalachian features of the northeast. Much of the complex structure of the west coast of the Inited States is clearly depicted. Analyses of terrain data of the east-

The diates is clearly depicted. Analyses of terrain data of the easiem United States suggest a correlation between regions of selemblty and certain of the terrain teatures
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The scale of the man that is shown is approximately 1:30,000,000 show many
amaler features, usually extensivellines triends or areas of terrain of
distinctive morphology. These teatures are thought to be surface as:
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are since and virtually unexpiblised information source and should be
useful in a wide variety of sant science investigations. (Proto cour.)

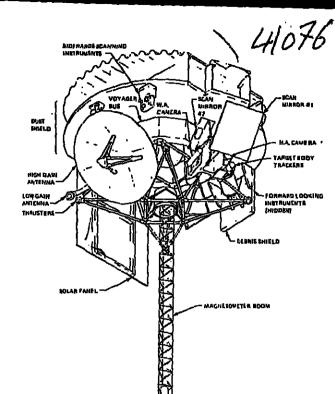


Fig. 1. The Halley Intercept Mission spacecraft.

These aims lead to a number of practical requirements on any mission to Halley:

(1) Accurate targeting of the spacecraft to a preselected point within the zone of parent molecules next to the nucleus. (2) Good imaging of the nucleus.

(3) An 'observatory phase' during which imaging of the tail and come at progressively increasing spatial resolutions will be obtained.

(4) Sufficiently long observation time for in situ measurements to cover the full 107-km scale of phenomena at Halley. The Halley Intercept Mission is based on a three-axis-sta-

bilized spacecraft. This allows significantly better imaging than can be achieved with most spinning spacecraft. A framing camera on a fixed-attitude spacecraft is the best means of achieving an observatory phase during which sequences of pictures are taken of the comet's tails and extended coma. Furthermore, with a framing camera, onboard optical naviga-

Halley Intercept Mission Typical Psyload

- Instrument	Maas, kg	Power, W	Dala, kbps
Neutral mass spectrometer	6	5	2
ion mass/velocity spectrometer	7	11	3
Electron analyzer	4	3	2
Magnetometer	3	5	1
Plasma wave analyzer	4	7	1
Dust composition analyzer	11	12	3
Dust counter	3	3	1
Remote sensor	12	8	2
Subtotal	50	54	15
Imaging	76	38	90
Total	126	92	105

tion can deliver the spacecraft to the selected point in the target plane with an accuracy of ± 90 km (1 σ); the most optimistic estimate of delivery accuracy without onboard navigation is ± 500 km (Giotto). With optical navigation, it is thus possible to make sure the spacecraft passes through the zone of parent molecules which extends $\sim 10^3$ km from the nucleus, on the sunlit side, at a great enough distance to avoid smear in the highest resolution pictures.

-- FOR WALRS HA I HALY U, 1801 TO

The Halley intercept spacecraft (see figure) has a total mass of ~1600 kg, of which 300-400 kg will be allotted to the dust shield and ~125 kg to the science payload. A possible science payload is summarized in the table.

Halley goes through perihelion (0.6 AU) on February 9, 1986. A major advantage of the Halley Intercept Mission is that it can intercept the comet either before or after periheli-

Earth Radiation Budget Satellite

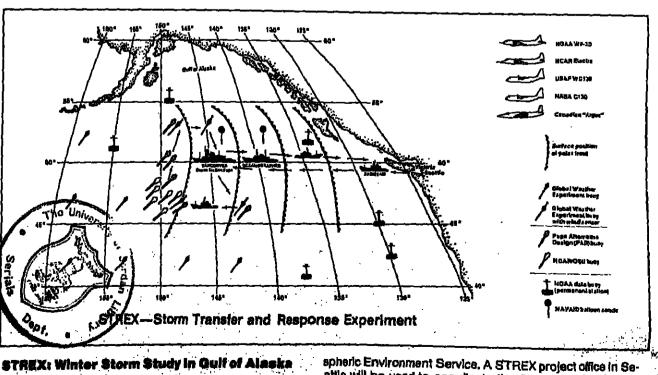
A satellite to measure the earth's radiation budget is to be integrated, tested, and delivered ready for launch on the space shuttle by April 1984. Although there have been Earth radiation budget instruments in NASA's experimental NIM-BUS 6 and 7 spacecraft, this will be the first time this factor can be measured on a global basis over a 24-hour day. The earth absorbs more solar energy in some regions and emits more thermal energy in others. This heating differential sets wind and ocean currents in motion to transfer heat from heated to cooled areas. Hence, the earth's radiation budget, as a driving force for weather, is one of the factors on which comprehensive data are needed for better weather and climate predictions.

The satellite, with its Earth Radiation Budget Experiment instruments, will become part of a three-spacecraft system. with NOAA-F and -G, to use scanning and nonscanning radiometers to measure the amount of solar radiation received and given up by different regions of the earth. The satellite will include systems for power, command and data handling, attitude control (three-axis stabilized), orbit adjust, as well as a thermal control. The spacecraft will communicate via the Tracking Data and Relay Satellite System. After launch by the space shuttle, the satellite will boost itself into a 600-km (373-mile) circular orbit, inclined 46° to the equator.

The Ball Aerospace Systems Division of Ball Corp., Boulder, Colorado, will provide the Earth Radiation Budget Satellite as well as its mission operations support. The contractor's proposed estimate of this cost-plus-award fee contract is approximately \$21 million.—PMB 6

Status of Voyager Spacecraft: Update

	Voyager 1	Voyager 2	
Spacecraft distance from Earth, km	1,449,237,000	1,194,436,000	
Spacecraft distance to Saturn, km		221.532,000	
Spacecraft distance traveled since launch, km	2,264,300,000	1,964,094,000	
Spacecraft velocity relative to Earth, km/s	28.6	20.5	
Spacecraft velocity relative to aun, km/s	21.5	16.4	



STREX: Winter Storm Study in Quif of Alaska

U.S. and Canadian invastigators are probing the initial stages of the large storms that dominate North American winter weather. In a study called STREX (Storm Transfer and Response Experiment), researchers aboard ships and air-Response Experiment), resparchers about diships and allcraft are examining how energy and water vapor feed from
ocean to atmosphere: This action fuels the large storms that
rage across the Gulf of Alaska. The low-pressure systems
diffit ashore in western Canada and the Pacific Northwest,
break up over the Rockies; and then reform into major systems that control wither weather from Canada to Texas.

It is believed that new religious and lead to a better understanding of the North Alfrendalt climate. The experiment is man-

of Naval Research, U.S. and Canadian Coast Guards, Canada's Institute for Ocean Sciences, and Oregon State University During the experiment, research ships, aided by burds de-ployed in the path of the storm, will take meast rements from below the sea surface to housands of feet in this sir. Also research airplanes will probe the advancing atom fronts. As

attle will be used to coordinate the 6-week study. (Other

Aeronautics and Space Administration, U.S. Air Force, Office

STREX participants include the National Science Foundation, National Center for Atmospheric Research, National

many as 10 storms should cross the Gulf of Alaska during the experiment, which ends in mid-December, STREX goals include improved weather forecasts and

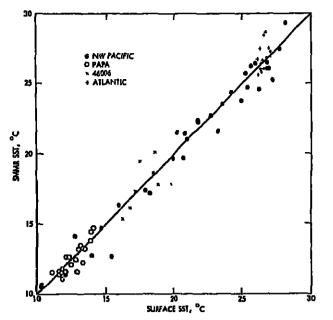
Sea Surface Temperature Measurements from SEASAT

In its short lifetime, the SEASAT Scanning Multichannel Microwave Radiometer (SMMR) observed the world's oceans for almost 100 days in the summer of 1978. This was done in order to determine sea surface temperature (SST), wind speed at the ocean's surface, rain rate, and the integrated column density of water vapor and liquid water in the almosphere. These parameters are deduced from measurements of both horizontal and vertical polarizations of radiation at five microwave frequencies from 6.6 to 37 GHz.

SEASAT was a 'proof of concept' satellite to determine how accurately microwave sensors could measure important parameters of the oceans. The SST measurements examined so far are encouraging. They have been compared to nearly 100 high-quality surface observations under a variety of conditions and have been found to possess a negligible bias and to be accurate to within 1° over a wide range of values (10°-30°C).

The comparisons have been made in four major geographical areas: the northwest Pacific, the Guif of Alaska, the tropical western Pacific, and the western Atlantic near Bermuda. The results are shown in the figure. The scatter about the perfect agreement line is 0.8°C, and an error analysis shows that most of the scatter is due to thermal noise in the measurements and not to errors in geophysical modeling.

There are several limitations that must presently be accepted in order to achieve better than 1° accuracy. The most serious one is that measurements must be restricted to the open ocean-largo land masses within 600 km bias the SST retrievals. Also, radio frequency interference, sunglint, and heavy rain sometimes degrade the measurements. Fortunately, these restrictions only affect a small percentage of the entire data set. Furthermore, it may be possible to improve the algorithms so that they obtain accurate SST retrievals in



spite of these restrictions. In any case, it is becoming increasing clear that not only has SEASAT fulfilled its goal of validating the accuracy of microwave remote sensing but also that the SEASAT data set itself should prove to be a valuable

resource for geophysical investigations Further comparisons to accurate surface observations are desired, especially in areas of the world not yet examined. Anyone with access to accurate SST observations made at least 300 km from large land masses during July-October 1978 are encouraged to communicate with Thomas J. Chester, JPL 238-420, Pasadena, California 91109.

Dr. Chester of the Jet Propulsion Laboratory is the contributor of this news item. \$8

Radon: Clue to Earthquake Magnitude

Radon's flow within the earth's crust could offer seismol gists clues about the magnitude of an impending earthque according to a model proposed by Robert L. Fleis General Electric Company physicist, at the AGU Fall Ma last month. His work suggests that an extensive netw radon monitoring stations would be useful for early vof potential damage areas of the pending tremors.

Small amounts of radon, a gas released by the deca uranium, tends to move slowly within the earth's crust voter rocks are relatively porous. Velocities of a few inches are typical. Shifting stresses in the earth's crust that an earthquake can speed up or slow down radon's

Earthquakes registering low on the Richter scale e. . . . stresses on the earth's crust only strong enough to still imaffect radon flow in rocks, says Fleischer. These smoreors impact radon's flow over relatively short distances ger cordingly, stronger quakes have a greater impact ov:

For example, Fleischer's calculations show that we are rating 5 on the Richter scale should not influent more than 96 km away. A major earthquake, such T 1979 Alaskan quake, measuring 7.7, could affect ra::::

The model proposed by Fleischer is based on a decident model and on the assumption that crustal stress incl with earthquake magnitude. He reports good correl: tween the model and recorded fluctuations of radon: ...enprevious earthquakes. A similar model used by Sov. tists shows similar correlations with other data,—BT& ...

er a nicely balanced account of how one goes about measuring and interpreting physical oceanographic data.

Chapter 7, 'Circulation and Water Masses of the Oceans' (85 pages), although briefer than its companion chapter in Sverdrup, Johnson, and Fleming's The Oceans, is of course considerably more up to date. Pickard has achieved a measure of brevity by intentionally neglecting peripheral regions and by emphasizing modern research in the principal ocean basins. Although there is a wealth of reasonably accurate detall in this chapter, the interested reader will find it difficult to obtain more information because the sources are not cited.

The final two chapters and the appendix briefly outline coastal and estuarine oceanography, suggest future work, and discuss physical oceanographic units (20 pages total). An annotated list of suggested readings completes the text.

The revisions are in the same 'cut and paste' style used in the previous edition. This may reduce errors, but does not eliminate them. At least two errors were introduced with the change to SI units, and several other errors either persist from past editions or are introduced here. All errors are minor and should cause little confusion.

This text represents a comprehensive subject covered by lew pages; hence certain topics are slighted. I missed the development of a historical perspective (only very briefly outlined) and the use of appropriate mathematics. While the nonmathematical approach will perhaps avoid frightening the nonphysicists, and while most of the essential mathematics is covered at an appropriate level in the companion volume (Pond and Pickard's Introductory Dynamic Oceanography). the book would have benefited from a discussion of the quasi-mathematical aspects of the distribution of variables.

Also, there has been no increase in the third edition in the use of figures to illustrate the text. Most sections would great-

ly benefit from an increased use of graphics. My stronges criticism is that the oceanographic literature is not properly cited. Thus the student who wishes to learn more about specific subjects cannot use this book as a starting point. Proper literature citations would add little length to the text, would not be confusing, and would greatly increase the usefulness and value of the text. I would cite Perry and Walker's The Ocean-Atmosphere System as an example of a related text which presents a better historical perspective, contains appropriate mathematical development, uses ample graphics, and provides proper literature citations, yet achieves this without becoming inaccessible to the nonmajor.

The third edition does, however, continue the evolution of Pickard's text into a much-needed niche in the oceanographic literature. The book does not accomplish everything one might hope, and in particular is weak on its own for introductory courses for physical oceanography majors, but I feel it is very nearly the best that can be done within so few

The value of this book is that it provides in one brief, wellwritten volume the rudiments of physical oceanographic aspects of water mass analysis, along with the inferences such analysis provides of the characteristics and circulation of the oceans. This is an important subject not well discussed in most other texts in recent years. I would recommend this book to any person wishing a straightforward introduction to the subject. Graduate students from all oceanographic disciplines may well find it to be essential reading prior to general examinations.

James H. Swift is with the Marine Life Research Group, Scripps institution of Oceanography, La Jolla, California.

AGU **Congressional Science Fellowship**

The individual selected will spend a year on the staff of a congressional committee or a House or Senate member, advising on a wide range of scientific issues as they pertain to public policy questions.

Prospective applicants should have a broad background in science, be articulate, literate, flexible, and able to work well with people from diverse professional backgrounds. Prior experience in public policy is not necessary, although such experience and/or a demonstrable interest in applying science to the solution of public problems is de-

The fellowship carries with it a stipend of up to \$25,000 pius travei allowances.

Interested candidates should submit a letter of intent, a curriculum vitae, and three letters of recommendation to AGU. For further details, write Member Programs Division, Congressional Fellowship Program, American Geophysical Union, 2000 Florida Avenue, N.W., Washington,

Deadline: March 31, 1981.

THE UNIVERSITY OF JORDAN AGE, NO. 41076 DATE THE TOTAL

New Publications

Modeling and Control of River Quality S. Rinaldi, R. Soncini-Sessa, H. Stehlest, and H. Tamura, McGraw-Hill Ser. in Water Resour. and Environ. Eng., McGraw-Hill, New York, xiv + 380 pp., 1979, \$49.50.

Reviewed by Kenneth J. Laniear

This book is a major work in the field of mathematical water quality modeling, providing an in-depth treatment of modeling and control techniques.

Chapter 1 is a meticulous and comprehensive discussion of modeling theory and terminology. Equations are expressed in a matrix notation which is employed consistently throughout the book and proves to be a powerful vehicle for presenting complicated models in an understandable manner. Chapters 2 and 3 examine water pollution processes and quality indicators and the different components of water quality models. Emphasis is on the forms of the various equations, rather than on the specific parameter values. Chapter 4 lies the earlier chapters together by looking at the construction of self-purification models, particularly the Streeter-Phelps model and its variations. Also interesting is a section on ecological models using Michaelis-Menton relationships.

The strength of the book is clearly in its presentation of modeling theory. By using its concise matrix notation, it provides excellent explanations of how such effects as photosynthesis and distributed BOD loadings are incorporated into model equations. Some weaknesses on the practical side are evident. For example, in discussing ways to estimate the reagration coefficient, only river depth and velocity are considered, ignoring recent formulations based upon energy dissipation.

Chapter 5, 'State and Parameter Estimation,' presents a major aspect of the book's modeling philosophy: Establish the modeling equations, then determine the parameters of these equations on the basis of observations of the system output. This is a sound technique, provided that past observations are appropriate for predicting future system performance. It also explains why the book devotes relatively little space to more conventional methods of estimating parameter values. The modeling philosophy will not apply. however, where such actions as stream channelization or drastic attenations of waste loadings cause the hydraulic or biological parameters to change.

One example in chapter 5 of a Streeter-Phelps model of the Bormida River is illustrative of the book's strength in modeling theory and weakness in practical application. In a demonstration of skillfully applied mathematics, the model equations were manipulated until a one-dimensional searching algorithm could be applied to estimate the parameters. However, no correction was made for the dissolved oxygen becoming zero (and changing the deoxygenation coefficient) in some of the calibration data sets. The resulting predictions of minimum dissolved oxygen are unimpressive, considering the abundance of calibration data. Chapter 5 presents even more advanced techniques. such as Kalman filters, suboptimal recursive filters, and recursive filters in time and space, but some of these are tested against synthetic model data, not field data.

The final five chapters cover such topics as control theory, linear and nonlinear programing, unsteady state control, water pollution control facilities, river basin management, and multiobjective programing. In each of these, the approach is to formulate the problems and to discuss briefly the available solution techniques. In this way, an extensive amount of

useful material on theory is covered without excessive emphasis on details

This book is definitely not for the casual reader. Understanding it takes time, concentration, and a reasonably solid background in mathematics. I would highly recommend it, however, to students of advanced water quality modeling and to practitioners facing difficult modeling situations that require advanced techniques.

Kenneth Lanfear is with the Research and Training Branch, Environmental Affairs Office, U.S. Geological Survey, Reston, Virginia.

Geology for Civil Engineers A. C. McLean and C. D. Gribble, Allen and Unwin, Winchester, Mass., xviii + 310 pp., 1979, \$25.00.

Reviewed by Ivan C. James II

A course in engineering geology was not offered the semester that I wanted to take it so I took the introductory geology course. I have always suspected that I had missed assimilating those magical formulas of rock mechanics, tunneling, and dewatering that the aspiring civil engineer dreams of using to speed his project through difficult terrain. McLean and Gribble have taken an alternative approach. Their book is not engineering geology nor is it just introductory geology, but they lay claim to geology for civil engineers as suggested by their choice of title. My impression is that they have written four chapters of geology followed by four chapters of engineering geology.

This is a distinctly British book with emphasis on glacial morphology, the use of terminology which may be unfamiliar to North American practitioners (e.g., greenfield sites, dumb wells, finite reserves, etc.), and the application to predominantly British field examples. References to the British Code of Practice and citations of information sources are also much more suited to the British student or practicing

On the whole, this book is readable, well presented, and appropriate for an introductory semester or quarter course in the subject. A strength of the book is the introduction of terminology in boldface type with the definition in context. This, coupled with a good index, should ald the practicing engineer faced with terms unfamiliar to his normal vocabulary. A lack of balance exists between some chapters as exemplified by the attention given to formulas in applied geophysics, McLean's specially, and the lack of virtually any discussion of computational or analytical methods in the chapter on subsurface water. Although one example is the inattention to the units appropriate for the formula for subsidence found on page 189, mistakes appear to be few.

'Ivan C. James II is the District Chief for New England, U.S. Geological Survey, Boston, Massachusetts.

Descriptive Physical Oceanography G. L. Pickard, Pergamon, New York, ix + 233 pp., 1979.

Reviewed by James H. Swift

This new edition of G. L. Pickerd's enjoyable text, published only 4 years after its predecessor, shows continued improvement over the original edition. Not only are most topics brought up to date but also the book is slightly more comprehensive, and thus it is more nearly representative ern deep-sea synoptic physical oceanography. The L '3rd (SI) Edition' is somewhat misleading, since few o revisions are related to the minor matter of conversic

The overall organization of the text remains the same though the page count has grown slightly. The first fo ters introduce the author's approach to his subject, or the general nature of the ocean basins, define the imp physical properties of seawater, and describe their typedistributions (47 pages total). The heart of the book, coming three-fourths of its pages, is found within the next

Chapter 5, 'Water, Salt and Heat Budgets of the Oce-(27 pages), is a fine introduction to the definitions of the ous terms in the most common mass and heat budget equa tions. The regional variations in the individual components are not illustrated. This is unfortunate because such figurwould make this a first-rate chapter. The budgets themse (i.e., the combination of the various terms) are only briefly mentioned, and then in global form only.

Chapter 6, 'Instruments and Methods' (43 pages), is a gem. The Instrumentation most common to physical oce? graphic field work is nicely covered, and there is some c cussion of the relative merits of the various techniques. Moreover, this has been combined with an effort to demoin strate how the interests of physical oceanographers have? motivated the most common interpretative methods. The chapter is in no way a field manual, but it does give the read-

noaa atlas 3,

THE CENTRAL NORTH ATLANTIC OCEAN BASIN AND CONTINENTAL MARGINS: GEOLOGY, GEOPHYSICS, GEOCHEMISTRY, AND TRANS ATLANTIC GEOTRAVERSE (TAG)

BY PETER A. RONA, NOAA

- . 22 MAPS ILABITUDE TO N to 50 Ni
- · BOTTOM PHOTOGRAPHIC TRAVERSE
- . SEISANG REFLECTION PROFILES
- . 12 GEOFFAVIRSES IBADITMETRY GRAVITY MAGNETICS: . PHYSICAL AND CHEMICAL PROPERTIES OF CRUST
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POSITIONS AVAILABLE

Intergevernmental Personnel Assignmental/Office of Surface Mining. The Department of the Interior anticipates a few openings for lamparay appointments of earth scientists during 1981 or 1982. The assignments would involve a detail from the scientist's present employer for one or two years. The present employer must be a State or local governmental entity (including state universities). The assignment would be with the Technical Analysis and Research Division of the Region V Office in Denvar, Colorado or with one of the Western ice in Denyer, Colorado or with one of the Western State's regulatory offices. Principal activities would involve technical and environmental reviews of delalled proposals to mine coal and recisim disturbed lands and provision of technical assistance to coal

rise operative and regulatory agency personnel.

Individuals in the following disciplines are needed:

I. Hydrology—emphasis on quantitative salimation of physical and chemical effects of mining and reclamation on the hydrologic statem. The release of the control of the contr item. Development of systems approac to estimating the cumulative hydrologic el-lects of site-specific and regional mining. Mining Engineering—emphasis on com-parison of mining techniques to recover addional coal and to reduce environmental eftects, prediction of subsidence over under

nd mines; and eatimation of devernent of approximate original con-Almospheric Science — emphasis on predicthe modeling of fugitive dust sources and

Geological Engineering—emphasis on ex-ploration geophysics (each as shallow esis-mic, resistivity, well log interpretation), soil and rock mechanics, and blasting (for min-lan) is purposes of the assignments are to assist the

Oto of Surface Mining, and state regulatory authorities in the review of mining and reciamation plens for the extraction of coal from federal lands and in envi-These assignments are intended to provide the solution Mining Control and Reclamation Act and residual distantial and control and Reclamation Act and residual distantial and control and Reclamation Act and residual distantial and reclamation and reclamation in oralled lederal and state statutes and regulations in or-der is improve his effectiveness upon return to his

odu esignment. historia, qualified individuals and entities includ-Interested, qualified individuals and entitles including size and local agencies and educational institutions, are encouraged to contact the Office of Surface Manage, Brooks Towers, 1020 18th Street, Denter, Colorado 80202 (Atm. John Hardaway, Technical Analysis and Research Olyselon) with perfect intert information regarding skills and interest. In although the Desparation of Interest are encouraged as soon as possible Scientists must meet conflict of interest requirements adopted by the Office of Surface Mining. The Desparation of an equal obportunity embloyed. Research Associate Position. The Geophys-ics Program at the University of Washington seeks applicants for a research associate position in space physics, beginning June 1981. The position is supported by research contracts and grants. The applicant should have a Ph.D. and be experienced in Xray and charged particle detector techniques as ap-plied to space and autoral research, in addition to having good background in space plasma phenome na. interested persons should send their resumes to George K. Parks, Geophysics Program AK-50, University of Washington, Seattle, WA 98195.

The University of Washington is an equal opportu-

nity/affirmative action employe

institute of Space and Atmospheric Studies/ University of Saskatchewan. Applications are invited for posidoctoral research positions in auroral physics and atmospheric dynamics. Term is one year renewable. Experimental ability or ex-perience with optical or radio techniques is desirable Work may involve rocket; balloon or observatory neasurements and their interpretation. Send resume, elerences and research interests to: D. J. McEwen, Institute of Space and Almospheric Studies, University of Saskatchewan, Saskatoon, Canada S7N OWO.

Yale University, Department of Gaclegy and Geophysics. Applications are solicited for a faculty position in petrology or mineralogy to begin in the seedemic year 1981–1982. Areas of special interest to the department include theoretical and ex-perimental mineralogy, petrology, and field studies. Yale University is an equal opportunity/affirmative sction employer and encourages women and mem bers of minority groups to compete for this position.

Curriculum vites, publications, and the names of Curtoulum vises, publications, and the harries three or more referees should be sent by January 31, 1981, to Robert B. Gordon, Chairman, Department of Geology and Geophysics, P.O. Box 6866, New Haven, CT 08511.

\ssociate Director/Marine Science institute. The University of Texas at Austin seeks to fill Science institute. The associate director is responsible for research and intellectual leadership of the institute's Galveston Geophysics Laboratory. The position carries the line responsibility of senior sdninistrator for the Galveston Geophysics Laborator Dulles include research planning and managemen and shop operations, administrative supervision, ilaison with industrial and agency sponsors, represents tion and other directorable duties.

The Galveston Geophysica Laboratory maintains modern computing facilities, research laboratories. and two deep-ocean research vessels, the R/V Fred and two deep-ocean research vessels, the RV Fred Moore and the RV lds Green, Research at Galveston includes programs in menine geophysics, marine geology, solid earth geophysics, earthquake and extra-terrestrial selsmology, and instrument systems design, both basic and applied.

Applicants are saked to send the following:

(1) Vita—including list of publications.
(2) Brief statement on current research and

- support.
 (3) Brief statement on administrative experi-
- ence.
 (4) Brief statement on teaching experience. Names of six persons who may be con-tacted for personal and professional reco A letter of application and the above requested in

formation should be sent to: Dr. J. Robert Moore, Director Marine Science Institute

Marine Science Institute
University of Texas
P.O. Box 7999, University Station
Austin, Texas 78712
Salary biased on qualifications. Ph.D. required.
This successful candidate will also be considered for tenure appointment in the Department of Marine, Studies. Position to be titled as abon as posetics. Studies. Position advised. Position located in Gallies. Planty application advised.

Resparch Assistants/Utah State University. Exciting opportunities at the frontiers of knowledge exist for graduate and undergraduate research assistants in the Department of Electrical Engineering at Utah State University. USU, located at the base of the Wasatch Mountains, is engaged in ground-breaking investigations in many chilcal fields Get involved in environmental sensing, digital etectronics, microprocessor applications, electro-optics, or computer angineering. Do space and atmospheric ground, in rockels, or aboard the space shultle. For details on these and other projects, contact Doran J. Baker, Head, Department of Electrical Engineering, UMC 41E, Uleh State University, Logan, UT 84332

(telephone: 801/750-2840). USU provides based only upon performance.

University of Hawall. The Department of Geology and Geophysics of the University of Hawati is seeking applicants for a tenure track position, beginning July 1, 1981, in either of the following helds: (1) ectonics of ocean basins and margins, (2) pale-

Applicants should have a Ph.D. degree and a demonstrated ability to conduct and promote marine resourch. Ability to (each at all levels is required. The position will be a joint one on an 11-month basis with the Hawaii Institute of Geophysics. The appointment will be at the rank of assistant professor. Apply with resume and names of three references to Saymour O. Schlenger, Chairman, Department of Geology and Geophysics, University of Hawali, Honolulu, Hi 96822. Closing date is April 15, 1981.

The University of Hawaii is an affirmative action. equal opportunity employer

RESEARCH **OCEANOGRAPHER**

The Radar and Optics Division of ERIM requires a Radar Oceanographer, preferably at the PhD level. to function as head of the Oceanographic Measurements and Analysis Group of the EM Measurements Department. Experience as an Oceanographer including EM measurements of oceanographic phenomena is required. Experience in the management of research programs is desirable. Candidates should have knowledge of EM remote sensor systems and techniques. The EM Measurements Department conducts research programs to apply EM measurements techniques to oceanographic problems.

ERIM, a non-profit corporation, is a center of research and development on sophisticated sensors and data processing techniques used by the Department of Defense and other agencies engaged in remote sensing.

ERIM is located adjacent to the campus of The University of Michigan in Ann Arbor. The Ann Arbor area has exceptional academic, cultural, entertainment and recreational opportunities.

Send your resumé and salary requirements in confidence to John J. Malik. U.S. citizenship is required."

ERIM P.O. Box 8618

Ann Arbor, Michigan 48107

An equal opportunity employer.

Sedimentary Petrologist. The Goology Department at the University of Vermont is seeking a sedimentary petrologist for a tenure track position a the assistant professor level. Research and teaching specializations should be in classic sedimentary petrology with colential ancillary interests in petroleu geology, geomorphology, and hydrology. It is ex-pected that the successful candidate will establish field-oriented research program which includes su-porvision of graduata (M.S.) and undergraduate stuhighly desirable. The Gaploov Department at the University of Vermont is a seven member department having an M.S. program and a definite commilment to excellence in undergraduate aducation Applications will be accepted until April 1, 1981.

Candidates should send a resume and arrange for

three letters of reference to be sent to Acting Chairman Department of Geology University of Vermon Burington, Vermont 05405
The University of Vermont is an equal opportunity-

firmative action employer.

Yele University, Department of Geology and Geephysics. Applications are solicited for a faculty position in solid earth geophysics to begin in the academic year 1981-1982. Areas of interest to the department include seismology, exploration geophysics, mechanical and physical properties of rocks

and minerals, geomagnetism, and tectorophysics. Yale University is an equal opportunity/affirmative action employer and encourages women and mem-bers of minority groups to compete for this position. Curriculum vitae, publications, and the names of three or more referees should be sent by January 31, Geology and Geophysics, P.O. Box 6666, New 11aven, CT 06511.

Bedimentary or Low Temperature Geo**chemiet.** This is an assistant professor, tonurc track position, although exceptional cardidates of geochemist to complement our strong programs in sedimentology, hydrogeology, organic geochemis-try, and basin analysis. The leaching load is three courses per year—one beginning level geology course, an upper level geochemistry course, and a graduate course of his/hor choosing, introductory go ology and summer field camp are also taught on a lern rotating basis. A well-equipped laborator and computer facilities are available. The potential exists both for outside funding and for cooperative

The successful candidate will be expected to conduct an active research program leading to publications. Applicants should submit a lotter of application, resume, a copy of each transcript, and have three supporting letters sent to.

Department of Geology Iniversity of Missour Columbia, Missouri 65211 The University of Missourt is an equal employment

Posidectoral Fellows/Department of Yerrestrial Magnetism, Carnegie Institution of Washington. Endowed postdoctors) fellowships In private institution, emphasizing maximum freedom of research in areas of geophysics, isotope and trace element geochemistry, mass spectrometry, planetology, and star and planet formation. Renewable for second year. Women and minority candidates en-1981. For information write Fellowship Committee Dept. of Terresidal Magnatism, Carnegie institution of Washington, 5241 Broad Branch Road, N.W., Washington, D.C., 20015.

Associate Program Director/MSF. The National Science Foundation's Division of Earth Sciences is seeking qualified applicants for associate program director, Geophysics Program. This position is excepted from the competitive civil service, EC-13/ 14 (equivalent to GS-13/14, \$32,048-\$49,229 per annum), and will be filled on permanent or 2-yeartional basis. A Ph.D. in geophysics is desirable Equivalent research and experience in the adminis tration of large, multidisciplinary research programs may be substituted for a degree. A broad general knowledge of geologic research and familianty with the U.S scientific community are also required. Applicants should submit a statement of interest and resume or SF-171, Personal Qualifications Statemen to the National Science Foundation, Personnel Administration Branch, Announcement Number EX 80-21, Rm. 212, 1800 G St., N.W. Washington, DC 20550. Attn. E. Paul Broglio (telephone: 202/357-

NSF is an equal opportunity employer

Graduato Assistantships/Physics and Astronomy. Graduate research assistantships and teaching assistant ships in the Depart mout of Physics and Astronomy of the University of lowe are available to well-qualified students The department has vigorous research programs in space physics, plasma physics physics, elementary particle physics, laser physics, nuclnar physics, and solid state physics. Assistantahips can begin in June, Augual, or January, Please address your inquity to Depart mont of Physics and Astronomy, The University of Iowa, Jown City, IA 52242.

Sedimentary Geoghamist. Princeton University seeks applicants for an assistant protossoratuo within the general fields of the chamistry of sedin tary systems or the geneals/diagenesis of sedimen-lary rocks. Further information may be obtained from David Crerar, 609-452-4123.

Submit applications, including vita, statement of research and leaching interests, and names of three

Sheldon Judson, Chairman Department of Geological and Geophysical Sci-

Princeton Universi Princeton, NJ 08544 eton University is an equal oped ative action amployer.

Chairperson. The Geoscience Department, Now Mexico Institute of Mining and Technology, is seek-ing a geoscientist of recognized academic and scien litic achievoment for the position of chairperson. The Geoscience Department currently has degree programs through the Ph.D. in the fields of ge try, geology, geophysics and hydrology. Dulles are to administer the department, conduct research, direct graduate studente and instruct in areas of interest. Ph.D. required, salary and rank ocen. Letter of apoli be postmarked prior to January 25, 1981 and sent to John R. MacMillan, Chairman of Search Committee, Geoscience Department, New Mexico Tech, So-corre, NM 87801.

Assistant Professorship/Department of Physics, University of Minnesots. We expect to fill a tenure track position at the assistant pro fossor level during the next two years. Priority will be given to candidates in space physics. Applicants will be judged in terms of their promise for outstanding scholarship in their research areas, promise for excellence in teaching, and the relation search programs to programs of the department.
Candidates should send a resume, bibliography,

Professor Walter Weyhmann, Head University of Minneaot 16 Church Street, S.E.

Minneapolis Minnesota 55455 The candidate should arrange to have at least three lotters of recommendation sent directly to the above address. The deadline for receipt of all materiol is February 1, 1980.

The University of Minnesota is an equal opportunity educator and employer The University specifi-

Computer Specialis/University Research Environment. The University of Rhode Island is seeking on individual to help implement a Sati Remote Sensing Software Package on our PRIME Computer System. Applicant should be interested in must be capable of managing his/her own time and cant must be available immediately.

The ideal candidate will have aworking knowledge of PRIME and DEC ASX 11 FORTRAN, operating system subroutines and Assembly Language, expo rience with satellife romote sensing systems or im age processing systems and a degree in computer science or software engineering Applicants with an appropriate subset of the above skills will be consid-

Salary range (2 \$19,310 to \$22,318 Benefits in clude 22 days vacation and a rural oceanside setting

in which to enjoy them Call or send resume before January I, 1981 to. Al Cuting, Graduate School of Oceanography, Computer Center South Ferry Rd , Narragansett, Rhode

(401) 792-6266 An affirmative action/equal opportunity employer

Faculty Positions: Astronomy/Space Phys-ics. The Department of Astronomy of Boston University invites applications for one or two tenure track faculty positions opening September 1981. Empha-sis will be placed on active research experience as well as interest in graduate and undergraduate teaching. We are considering good candidates from any field of astronomy or space physics. Applicants should sand resumes and the names of three references to M. O. Papaglannis, Department of Astronomy, Boston University, Boston, MA 02215. Boston University is an equal opportunity employ

Postdoctoral Research Associate/Mineralogy. Applications are invited for research in high-resolution and analytical transmission electron microscopy of minerals and their analogues. Experience in crystallography, materials sciences, or elec-tron microscopy is desirable. Send resumé (including transcripts), statement of research interests, and names of three references to P. R. Buseck, Department of Geology, Arizona State University, Tempe,

Arizona State University is an EO/AA employer.

Geophysics Research Associate. Weston Observatory of Boston College seeks MS in geophysics (doctorate work desirable), familiarity with time and frequency domain analytical techniques ige of FORTRAN programming. Oppo tunity for independent research along with assigned relating to New England seismic network. Salary to \$20,000 depending on qualifications and excellent benefits. Send letter and resume to Boston College, 140 Commonwealth Avenue, Chestnu11NJ. MA 02187.

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Exploration Qeophysics/University of Okia-homs. As part of a 5-year plan of development and expansion, the School of Geology and Geophy ics is looking for a person to form the nucleus of an exploration geophysics group APh.D. in geophysics is required, and preference will be given to someone whose teaching and research interests are in the acquisition, processing, and/or interpretation of serimic data. Present equipment includes a truck-mounted humper energy source, capable of panetraling a kilometer or more of rock, a portable, 12-channel seismic recolding system, gravmeters, magnetom ters; an electrical residivity unit; in-house may computers, and ferminals to the University's IBM 376 system: A geophysical observatory supports re-search in solid earth geophysics, and the exploration geophysicist would work closely with the fectiones-

sold earth geophysics group.

Applications are due February 15, 1981. Salary is compensive with industrial standards. Inquiries and applications should be sent to John Wickham, firector, School of Geology and Geophysics. University of Oldahoms, Norman, OK 73019.

The University of Oklahoma does not discriminate on the basis of race or sex and is an equal opportu-

Faculty Position. The Department of Geology of the University of New Mexico seeks applicants for a position in clay mineralogy, low-temperature gaochemistry, carbonate petrology, or economic geofogy. The appointment may be at the assistant, asso-clate or full professor level contingent on approval of funding from the university. The individual must be ommitted to teaching at both the underpreduate and graduate levels. In addition, he or she will be expected to develop a vigorous research pro-gram in his or her field of specialty and will be expecied to supervise graduate students at the M.S. and Ph.D. tayets. The closing date for application is April 15, 1981. Applicants should send a résumé, undorgraduate and graduate transcripts, three letters of releases, and a brief discussion of research interests to Rodney C. Ewing, Chalman, Department of Geology, University of New Mexico, 87131. The University of New Mexico is an equal opportu-

Virginia Polytechnic Institute and State University. Igneous Petrology and Geochemis try/Research Associate. Origin and tectonic significance of granitic rocks. Project involves petrogra nalytic chemistry mineral chemistry, isotopic stud les, and field mapping. Send réaumés to: D. R. Wones, Chairman Department of Geological Sciences

Virginia Poly. Inst. and St. Univ. Blacksburg, VA 24061 The University is an equal opportunity/aff/mative

Program Manager/Meteorology. Oceano graphic Services, Inc , is seeking qualified appilcants for the position of program manager for meteorological studies. Applicants should have an meleorological studies. Applicants should have M.S. or Ph D. in meteorology or atmospheric sciences, plus experience in the field. A broad general knowledge of air pollution, and an un-derstanding of the air pollution regulatory environ-ment, is helpful. Interested persons should send resumo, references, and salary history to R. C. Banks, Oceanographic Services, Inc., 25 Castilian Drive,

Resource/General Geologist. The University of Pittsburgh at Bradford will have a tenure track opening for a resource or general geologist in Sep-tember, 1981. This new position will serve an established two-year program in potroleum technology and a new, geology-based, four-year program in en-vironmental sciences. Rank and salary are negotiable. The candidate will be expected to teach insome of the following courses in the earth and envisome of the following courses in the college, ionimental sciences program: structural geology, ionimental sciences program: structural geology, ionimental sciences program is seen to the college in adstratigraphy, economic geology, coal geology, in ad-dition, the candidate will teach courses in the petroloum technology program that are compatible with his or her skills. A Ph.D. and some experience are preferred, but applicants with other qualifications will be considered. Preference will be given to those with

petroleum industry experience. Bradford is located in the Allegheny Mountains in an area rich in natural and recreational resources. Please send resume and three letters of reference to Cail Burgchardt, University of Pittsburgh at Bradford, Bradford, PA 16701.

The University of Pittsburgh is an equal opportuirmative action employer.

Selemologist. The State University of New York at Binghamton has a vacancy for a selamologist at search interest in exploration geophysics or earth-quake seismology and a solid theoretical background are encouraged to apply. A Ph.D. with 0 to 5 years of teaching, research, and/or industrial experience is appropriate for the position. Salary is negotable and competitive with academic institu ition is available in fall 1981. Please send resumé and the names of three references to Chairman, Geophysical Search Committee, Department of ical Sciences, State University of New York, nton, NY 13901.

State University of New York at Binghamton is an

Structural Geologist. The Department of Geosciences of Purdue University invites application for a tenure track faculty position in structural geology, starting in August 1981. Rank and salary will be i qualifications. A Ph.D. is required. The individual will be expected to teach undengraduate and graduate courses in structural geo ogy and tectonics, participate in summer field courses, and pursue an active research program. Preference will be given to a candidate with an appiled field orientation and a strong background in the quantitative analysis of field data. The depa has active programs in petrology, geophysics, and engineering geology and has a close working relationship with the geotechnical group in civil engineer ing and the Laboratory for Applications of Remote Sensing. Closing date for application is April 1, 1981. Appircants should send a resume, the names, addresses, and telephone numbers of three relerees, and a brief statement of research interests to R. H. McCallister, Department of Geosciences, Purdue University, West Lalayette, IN 47907.

Purdue University is an equal opportunity/affirma-tive action employer.

University of New Orleans/Geophysiolst. Applications are invited for a permanent fac-ulty position commencing August 1981, in explora-tion geophysics. The Ph. D. or equivalent experience

lee will be expected to teach graduale and undergraduate courses in geophysics and general geology, conduct a program of research, supervise treses and oversee a program in geophysics. The position wall be at the assistant professor level or higher depending on background. Applications are encouraged from individuals with industrial experience, ancluding recent retirees.

Applicants should send a letter outlining interest in position, complete resume, and three letters of recommendation to Dr. Gordon Frey, Department of Earth Sciences, Lake Front, University of New Orleans, New Orleans, LA 70122.

UNO is an equal opportunity/affirmative action em-ployer. Applications from minority groups are specifi-cally tryited.

Qeophysicist/University of South CarolinaThe University of South Carolina anticipates a new faculty appointment in geophysics for 1981, subject to adequate legislative funding. We are espe-cially interested in individuals who have expertise in the fields of exploration geophysics, selamic inter-pretation, or solid earth geophysics. This would be a 9-month, tenure track position at the assistant or associale professor level, beginning August 1981. Some start-up funds are available for major equip-ment purchases. The individual who fills this position would join the growing geophysical component of the Geology Department, which currently emphasizes seismology, regional tectonics, and paleomagnetics and would develop an aggressive research program

in his or her apecialty. Please send vitae and names and phone number of three individuals we may contact for references to Willard S. Moore, Chairman, Search Committee for Geophysics, University of South Carolina, Columbia, SC 29208. Closing date for this announcement is

The University of South Carolina is an affirmative action/equal opportunity employer.

ologists and Hydrologists/Saudi Arabia. The School of Renewable Natural Resources, University of Arizona, invites applicants to logy and Arid Land Studies, King Abdulaziz University, Jeddah, Saudi Arabia. One year, renew able positions in meteorology and hydrology are

 Ph.D. In meteorology with experience in undergraduate teaching and research. Curriculum in-cludes courses in meteorological instruments and methods of observation, dynamic meteorology, synoptio meteorology, physical meteorology, and cil-

M.S. in meteorology with practical experience in meteorologic operations and undergraduate teaching. Knowledge of WMO procedures.

 Ph.D. in a hydrologic science or engineering with experience in undergraduate teaching and in rement in an arid environment and in evaluating the

Description: The project is funded by the Saudi Arabian government through the U.S.-Saudi Arabian Joint Commission on Economic Cooperation. Admin latration and logistic support is provided by the U.S. mentation is by a contract with the Consortium for international Development. The goal of the project is to undertake technical cooperation to develop edu-cational programs for meteorology, hydrology, arid land studies and environmental protection.

Salaries and allowances: Highly competitive with 25% overseas adjustment, housing, car and other al-Availability: February 1, 1981, or soon thereafter

for spring semester; September 20, 1981, for fall se-mester. Initial appointment of one year or more contingent on performance Closing date: January 16, 1981 for spring semes

ter; February 15 for fall semester.
Application: The application should include the following: (a) a letter detailing principal qualifications and interests. (b) a curriculum vita. (c) name, address and telephone numbers of three references Send to Martin M. Fogel, Director, CID/King Abdula-ziz University Project, 317A Anthropology Building, University of Arizona, Tucson, AZ 85721, Telephone (802) 828-5344/2989.

EÉO/AA employer.

Hydrogeologist. The State University of New York at Binghamton invites applications for a permanent position in groundwater hydrology, starting fall 1981. It is desirable that applicant have teaching and research interests in one or more of the following: groundwater hydrology, modeling, flow through porous media, and environmental hydrogeology. However, applicants with interests in other areas will be accepted.

Teaching responsibilities will include both undergraduate and graduate courses. The opportunity exsta to initiate courses at all levels, but develops of one lower-level undergraduate course is essential. Research facilities include: electron microprobe, scanning electron microscope, X-ray diffractometers atomic absorption and transmission spectrophotometers, and access to a large central computer as well as minicomputers in department. Appointment is planned as assistant professor, but not necessar at beginning level. Salary is negotiable, but will be at competitive academic tev

Applicants should submit resumé and arrange for three letters of recommendation to be sent to James E. Sorauf, Chairman, Department of Geological Sci-ences, State University of New York at Binghamton, Binghamton, NY 13901.

State University of New York at Binghamton is an

CITIES SERVICE COMPANY

earch position in structural geology empha sizing the structural interpretation of selamb reflection profiles, using the latest selamic process ing/modelling techniques to interpret complex structures. Work with structural geologists and applied selsmologists. Rank and salary open send resume and the names of three re to: Richard H. Groshong, Cities Service Company, P.O. Box 3908, Tuise, OK 74102.

An equal opportunity employer M/F.

Bynoptie/Dynamic Meteorology. Description: The Geophysical Institute and Di-vision of Geosciences, University of Alaska, invite spokations from qualitied scientists for a full-time (2 month) laculty position at the Assistant or Assoc he Professor level. The successful candidate will be stationary in the second respect to the second of the second seco external agencies and to work cooperat ongoing research programs. He/she will be also ex-pected to teach occasional courses in synoptic/dyamic meleorology at the upper division and gradu

Qualifications: Ph.D. in meteorology. Research xperience in advanced analysis and diagnostic i global-scale meteorological processes is gaential, preferably over the full height of the atmo sphere (0-100 km). Preference will be given to appli-cants who can utilize their expertise in synoptic/dyamb meteorology to synthesize the results of var ous ongoing research projects in mesoscale and targe-scale meteorology, cloud physics, radiation, gonomy, and space physics into a better under standing of the large-scale meteorology of the North Pacific and polar regions. Teaching experience at the undergraduate and graduate levels is desirable Salary: Upward to \$34,600 (Asst. Prof.) or \$43,300 (Assoc. Prof.) per year, dependent upon

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Hydrogeologist. Applications are invited for a research position in hydrology, M.S. in hydrology or geology required, Ph.D. preferred. A minimum of 2 years experience related to water-air heat pumps, aquiler evaluation for heat pump application, and general groundwater hydrology. Position involves evaluation of Montana's equiters for heat pump use Send resume, copy of college transcripts, and inree references to E. C. Bingler, Deputy Director, Montana Bureau of Mines and Geology, Montana Tech. Butte, MT 59701, by February 1, 1981.
An equal opportunity/affirmative action employer.

Ocean Dynamicist. An academic position nure-earning track) for an ocean dynamicist is

qualifications and expertence.
Applications: For further information, including recent ennual research report, write to Director, Geophysical Institute, University of Alaska, Fairbanks, AK 99701. Closing date for applications is February 28 1081.

dynamics; synoptic analysis of oceanic data; and acoustical oceanography. The candidate should be willing and able to teach a variety of gradu courses in physical oceanography and related topics. The NAVPGSCOL has excellent computer. data archival library, and research vessel facilities The Department of Oceanography has close relations with the Fleet Numerical Oceanography Centar, Naval Environmental Prediction Facility, and faculty of lifteen and a student body of 80 to 100. The overall emphasis is ocean prediction with present faculty and student research in coastel ocean, polar ocean, and air-sea interaction processes. The scademic and research programs are conducted in close collaboration with the Departments of Meteorology and Physics. Salary will be determined by qualifications of the successful candidate. By January 1 if possible, send a curriculum vitae, the

statement of research and instructional interests to

Coeanography, Naval Postgraduate School (NAVPGSCOL). Present or ultimate research interest in area of naval oceanographic concern is desirable. Such areas include; ocean circulation

modeling, especially prognostication on the oceanic synoptic scale; surface and internal gravity wave

Faculty Search Committee, Department of Oceanography, Naval Postgraduate School Monterey, CA 93940. Visits by top candidates will be scheduled soon after. A decision will be attempted by March 1 and the position should be occupied by aboul June 1, 1981. The Naval Postgraduate School is an equal

COURSES

Call for Papers. Third international Ocean Disposal Symposium October 12-16, 1981 Alfred C. Redfield Auditorium Woods Hole Oceanographic Institution Woods Hole, MA 02543 For abstract and manuscript requirements, accommodations, student treval awards, and other inquiries

Dr. Iver W. Duedall, Symposium Chairman Marine Sciences Research Center State University of New York at Stony Brook Stony Brook, New York 11794

Meetings

Space Science Perspectives

The National Air and Space Museum will sponsor a free symposium, entitled 'Space Science Comes of Age: Perspectives in the History of the Space Sciences, on March 23-24, 1981. Included in the symposium will be discussions of solar astronomy from space, high-energy astronomy, lunar geology, lonospheric research, launch systems technology, and a history of LANDSAT.

For additional information, contact the National Air and Space Museum in Washington, D. C. 89

Ocean Energy Conference

Abstracts for papers to be considered for the 8th Ocean Energy Conference, sponsored by the Department of Energy, are due January 20. The conference, scheduled for June 7-11 in Washington, D.C., has as its theme 'Ocean Energy: Meeting the National Goals.

Papers dealing with systems orientation, industry involvement, new concepts, development planning emphasis, and technology/cost benefit projections are particularly desired. Papers stressing new and significant advances or concepts in materials, devices, or techniques relevant to ocean energy are also welcome.

Abstracts, limited to a maximum of 400 words, should be sent to Technical Committee Chairman, 8th Ocean Energy Conference, Marine Technology Society, Sulte 412, 1730 M Street, N.W., Washington, D.C. 20036. 🕉

Hellenic Arc and Trench Symposium

An International symposium on the Hellenic arc and trench will be held at the National Technical University in Athens, Greece, April 8-10, 1981. The formation and evolution of the arc and trench from land- and sea-based studies and the relation to the tectonics of adjacent areas will be the sym-

Comparisons with similar geotectonic structures, including the Tyrrhenian Sea and Pannonian Basin, will be made. Resuits of new oceanographic and space techniques and discussion of deep lithospheric and asthenospheric processes esponsible for the dynamics of the area will be emphasized.

For additional information, contact Xavier Le Pinchon, Director, Geodynamics Laboratory, Académie de Paris, Université Pierre et Marie Curie, 4 Place Jussieu, Tour 15, Premler Étage, 75230 Paris. 😂

Senior Position in Earth Science

The Earth Sciences Division of the LAWRENCE BERKELEY LABORATORY has several comprehensive BERKELEY LABORATORY has several comprehensive research programs involving the earth sciences. An opening exists for a person with an established national reputation in a scientific discipline in Earth Sciences ociences, preferably geomechanics or hydrogeo-ogy, to assume a position of responsibility for the scientific leadership and direction of major research programs such as concerned with adloactive waste storage.

Outles will include taking the scientific initiative and direction and management of angoing projects, in-oluding the nuclear waste isolation field involving more than 30 solentists and engineers of LBL and collaborative work with several academic and re-search organizations. Additionally, the position involves establishment of emerging programs, expan-sion of research (acilities and pursuit of new areas of

The successful candidate should have extensive ex perience and proven capabilities in directing and achieving programmatic goals of complex research projects involving teams of senior scientists and engineers. A PhD in a field of the Earth Sciences preferred with significant applicable experience.

Applications will be considered no later than April 1, 1981. Interested Individuals should forward two resumes including salary history to: Employment Office, LAWRENCE BERKELEY LABORATORY, One Cyclotron Drive, Berkeley, CA 94720. An equal opportunity



9th Caribbean Geological Conference

The ninth in a series of Caribbean Geological Conferences, which are held every 3 or 4 years, took place in Santo Domingo, capital of the Dominican Republic, from the 15th to 26th of August 1980. The conference, which was sponsored by the government of the Dominican Republic and the Universidad Catolica Madre y Maestra, was preceded by 2 days of field trips and was opened by President Antonio Guzman on the evening of the 17th of August. Generous support was provided by Alcoa Exploration Co., Falconbridge Dominicana, and Rosario Dominicana.

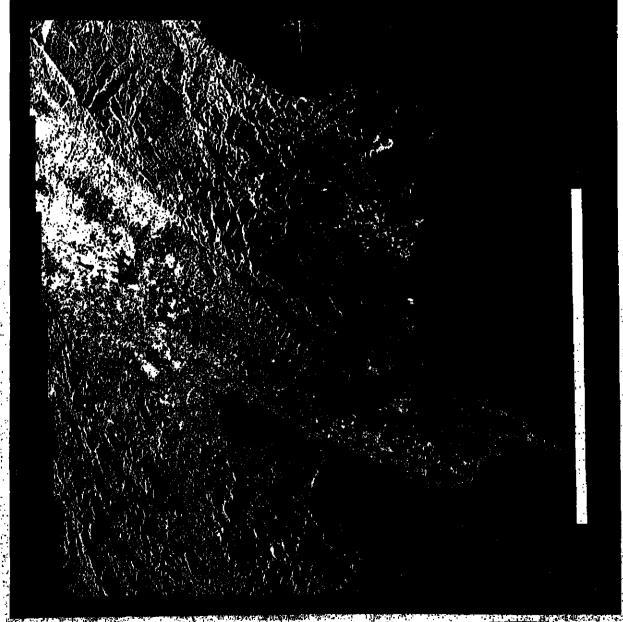
Geologists and geophysicists from 25 countries presented about 130 papers on a wide variety of topics ranging from geophysics to paleontology. While the whole Caribbean area was discussed, there was special emphasis on the northern Carlbbean and Hispaniola, as befitted the site of the conference. The contribution of workers from the Direction General de Mineriá was particularly notable.

Much of the structure, geophysics, and petrology sessions was directed toward attempting a clearer understanding of the tectonic development of the Caribbean region. Most papers concentrated on the geometrical, geophysical, and geological constraints rather than on comprehensive models. A

panel discussion on the tectonics of the northern Caribbean summarized the widely differing opinions on the development of that particular region.

There seemed to be a general consensus of opinion that the neolectonics of the northern and southern boundaries of the Caribbean plate are dominated by zones of simple shear, with localized compression related to the eastward movement of the plate in relation to North and South America, New evidence from Jamaica and Hispaniola demonstrated that this is a wide zone (at least 200 km), as in the southern boundary. However, the time of initiation of this deformation is still somewhat obscure.

Other than agreement that the pre-Tertiary tectonic pattern must be constrained by the relative positions of North and South America throughout Jurassic and Cretaceous times, little consensus of opinion on the earlier development of the Caribbean was reached. There was agreement that arc systems dominated, but there was much discussion on the age, number, relative positions, and polarity of Cretaceous island arcs. Despite a wealth of structural, petrological, and geochemical data on Cretaceous igneous and metamorphic rocks, including new data from Jamaica and Hispaniola, the



This satellite radar image of the northeastern Dominican Republic, on the Island of Hispaniola, was acquired by NASA's Seasat satellile, which was built and managed by the Jet Propulsion Laboratory. The image is approximately 100 km on a side, and north is toward the upper right. The line through the image center is the result of a radar calibration pulse.

lalands of the Greater Antilles group ile on the northern boundary of the Caribbeah plate. Strike slip motion along this boundary is evident from major faults through the island of Hispanicia. Their trend is dominantly east-west, and in this image they strongly outline the Cities Valley (upper left to lower right). Left lateral movement along the faults is suggested by offset drainage patterns, notably in the lower center of the image. Wave gut terraces in Pietetocene-to-recent carbonates near Cabo Frances Vieto (peninsula in the upper right) suggest that repld uplift is also occurring along this portion of the piste boundary. (Photo supplied by T. H. Dixon, Radar Remote Sensing eam: Jet Propulsion Laboratory.)

nature of these arcs and their relation to modern arcs are still not clear. It became apparent (to this writer at least) that much could be accomplished by systematic isotopic studies on crystalline rocks to augment recent structural, stratigraphic, and petrological work.

The papers on sedimentology, stratigraphy, and paleontology were mainly concerned with Hispaniola. Recent work by two French teams, one from the Institut Francais du Petrole and the other from the Universite Pierre et Marie Curie, described thick Neogene sections in southern Hispaniola. These were interpreted as an equivalent of the underthrust sediments of the Muertos trough and as an Alpine-type flyschimolasse sequence, respectively. Stratigraphic and sedimentological investigations and tectonic implications for other parts of southern Hispaniola were also described. Stratigrephic, sedimentological, and paleontological studies of Tertlary rocks in northern Hispaniola were also discussed. This included a major presentation of results of an interdisciplinary investigation of classic Neogene sections by an international team coordinated by geologists from the Naturhistorisches Museum, Basie. Considerable controversy was generated by a new interpretation of rocks of the Scotland district, Barbados, as shallow-water deposits. Another paper pointed out that Barbados was likely to have been much farther west and nearer South America during the 'lime the rocks of the Scotland district wore deposited.

The sessions on volcanology were dominated by discussions by a University of Puerto Rico team on the character and mechanisms of pyroclastic eruptions in the Lesser Antilles. However, there were other interesting papers that dealt with the tectonic framework of the Lesser Antilles, geothermal investigations in Martinique, and the 1979 eruption of Soutriero, St. Vincent. Also of note was the description of the very recent alkalic volcanics of Hispaniola.

The economic geology section was one of the largest ever

at a Caribbean conference. The enigmatic Los Ranchos Formation in the Dominican Republic, which is the host of the western hemisphere's largest and oldest gold mine, was widely discussed, as was Caribbean metallogenesis, principally in Jamaica and Venezuela. Contributors from the Dominican Republic, Jamaica, and Venezuela also presented papers on petroleum and industrial minerals.

Marine geology has always figured prominently in the Car-ibbean Geological Conferences, and at this meeting, highlights included French studies of the submarine geology of the Lesser Antillean Arc and Aves ridge which were complemented by a report on a deep test (Saba Bank No. 1) that bottomed in Paleocene andesite porphyry. Papers were presented on the paleomagnetism of both northern and southern margins of the Caribbean which confirmed the substantial rotations in both areas indicated by earlier studies. The general absence of magnetic anomaly signatures from the Venezuelan and Colombian basins, and the possibility that struclures such as the Hess escarpments may be old fracture zones, were discussed. An assessment of the magnetic anomaly field of the Yucatan basin provides a useful basis for future research, and presentation of geoid anomalies of the Caribbean represented a contribution in a rapidly advancing

The conference was concluded by a stimulating (and demanding) 4-day field trip, which effectively presented a cross section of the geology of the Dominican Republic.

Further information, abstracts, and guidebooks can be obtained from 9º Conferencia Geologia del Caribe, Apartado 2719, Santo Domingo, Dominican Republic.

This meeting report was prepared by Gren Draper, who is with the Department of Physical Sciences, Florida International University, Miami, Florida.

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Geomagnetism and Paleomagnetism

1960 Time variations paleonageneties PARSETTIC OVERPRINTED IN SECTEDATION AUSTRALIA AND THE THERMAL HISTORY OF CTS REFER MARSET P.V. Schmitt (CSIRO Division of Mineral Physics, P.O. Loz 115, North Ryde, M.S.V., Amstralia, 211). P.V. Sinalst (CARA) obtains of Wisers, Payers, P.O. kay 15, North Ryde, N.S.W., Asstralia, 211 and B.J.J. Embleton The resolution of magnetic oversines in three different rich sypes in the Sydney Again has enabled their ages to be settented at 40 a.y.— 100 m.y. ago. The overprinting is asserbed to releted to the initiation of riffing i: processes releted to the interest of ricrary on the Tames for. Even allowing for high test flow, a considerable chickness (sp to 2 ba) of custhyden has apparently been arrisped off the gurden has apparently been arrisped off the station-seath resetting of contact rock at at at \$50 m.y. \$50. vittinite reflectance indicating heating to at least 100°C, and the presence of a miseral assemblage in turfers yooks indicating temperatures approaching 100°C. It is probable that many Atlantic-type (lift mergins may have tug, milli-computents, rifts, beat (low). J. Geophys. Reg., Red. Typer 8081769

Hydrology

II to Crambiness
Extendention of the state of the state of controlly the state of t Outsets, (escale) and Cavid Rebut Leg A new path of for determining the entsetting of actifier to entset on the late is presented. The marked is head on the chartest fate of devices of average his with distance of fate of devices of average the with distance of fate and appropriate of the dyalder. Pertaining from an appropriate decision in suggest fate with distance offshore gives a measure of souther heteropresistand, consequently as suggests of the ralighting of the estactopy determination. Let as a so the distance of fishory of the souther death and a characterists and souther death and a characterists. of the edictory determinative. Let go te the distance fishers, d the equilar depth and a the fraction of the surel fire from the shoteline to

2 to (1²(1-a)/b This make it reinstively eary to calculate au-last roy settes from State measurements of mosp-age flow through Lakebeds and a mail number of bornholes. The importance of the nativelysy ratte in controlling the offshare diagrifustion discounce. (Asinctrum, sergas aquiler, labe). 1100 Groundster CREATHAIRE CONTAINING TRANSFORT WITH ADDOPPTION AND TON EXCENTS CHRISTERS: METHOD OF CHARACTER-LUTICE FOR THE CASE WITHOUT DISPERSION R.J. Characters (Experient of Civil Engineering, The Latiensts, of Terms at Austin, Aussin, Terms,

The considerance of least at Austin, Austin, Tead, 207(2). Continuous transport in the ground-ster endrecrease with a storation and ion exchange chaosistry is considered. As is shown, there are practical cases for which the influence of hydrody, railed dispersion is regligible. For these cases the method of constatentials, for these cases the method of constatentials is used to formulate the transport prulies notified or any advantation isotherm and an arbitrary nation against selection and all the case of the exchanging cations and a general cation is employed in the delating with application to the emerging technologies of insituation of incommunication and inviting pasting attinuous lightness. Examples of contaminant mingrating and high responding age considered. gration and site restoration are considered. Waret Bezour. How-, Paper BOWlife

Meteorology

The state of the s

The residual to the second and intermedial and the second and the Courts. Fee. Legt., Paper 8011579

FIRE Chemical or measure and offening interactions as generous as a common of the Organic of Organic of

Using stanietes trapaigneric confisions in a labo Fifth Similated trapagates conditions in a laboratory study as well as of field mentionent data from Project GAMETAB (Cloud Atmospheric Memore-ments Experience on Tropagates & Arconde and Cause), an experienced in accompact has been compacted of the CH/Dy/MgO layer induced interfarence problem. These results indicate that, for the tropical marine boundary layer, the Qd interfarence level overseld with the level of the l

1.5 mt. Oil interference caticates in the case of the first trap-sphere were materialistly lower, being that for an everese "armitle" UV times energy of the first the calculations suggest that the calculation of July 2001 interference problem could be released at 11 further by factors of five to six. strong the use of very narrow OV tager rutoes the... . to 1 mg wa. f ms). Leathys. Pes, Lett., Paper 80L1530

3720 Climatology A CHANTE MODEL WITE CHYDDYNAMICS AND GEODYNAMICS M. Chil (Gourant Institute of Mathematica) Sciences, New York Chiwatalty, New York, 10012 Sciences. New York Chiversity, New York, 10012
UAA) and H. Le Treat
We present a highly simplified, mero-dimensional redsh of the climatic system. The model
attempts to incorporate me functions important on
the time scale of glaciation cycles, manuly 104,
107 years. In justicular, the radiation balance
of the occam-atmosphere, the plastic flow of
the earth ice sheets, and the viscous flow of
the earth ice sheets, and the viscous flow of
the earth ice sheets and the esthenosphere (upper
manule), which had not been taken into account in
revious energy-balance or igo-sheet models of
climate (Meetman, 1976; Füller et al., 1979).
The model exhibits free, self-crustained oscillations of on amplitude and period comparable to
those found in the poleocitimate record of glaciaticins, visc, ville is and ville years, respectively. Buth oscillations had already them found
in the simpler model of viller et al. (1978,
1973). The fact that nonlinear, self-mustained 1979). The fact that montaneur, self-suptained

in the simpler model of Fallen et al. (1978, 1979). The fact that monitoner, self-muntained oscillations also chick now the grounds, slightness of the fallent in interesting it offers sid support to the idea that unforced oscillations can actually asist in the real climatic system tited?. These qualitations are characterized by a quartur-phase last between ice extent and global temperature.

Given that the climatic system is a nonlinear carillator which a period off olio' years), it is expected that askronogical forcing at 19,000, 21,000 and 41,000 years will lead to subharmonic carillations with a period close to 100,000 years, the desirant period of qlactation cycles. Such affects have already been noticed in the work of Sichtleid and Westcan (1978) with an even simpler accels, including only shabler dynamics. The careful study of the interplay between internal techanisms and external forcing with comparable time states represents an interesting challengs to the theory of ice eyes, the results of such theoretical studies can also provide guidance for observational work. In particular, pariodicities of 0100' years) in the climate record and phase legs between the volume and canyerature appear to be supported by the mout temperature aggest to be supported by the most secast peleogeochemical investigations. J. Gerphys. Res., Green, Paper 8001784

field-controlless tools (Harring of the Cristals a.G. Pichards, A.W. Reafee and J.A. Iribaras Municrally of Totale)

The charging corses and the saturation values of the charge and potential have been determined for six motal evident with hypical tee cryatal thapes (Pallet, columns, meedle, plate and deadries) with different orientations in a uniquiar ion current, in conditions that make the tharring process isola-controlled. Hetal apheres of seeral sizes were also used, as a reference, it was found that the theory of field-controlled charging for apheres adequately describes the process for the shapes, provided the variable (tharge or potential) is multiplied by a factor depending on shape and orientation. Thus the saturation thorge per unit cross section expected to the ion current warried from 0.4 to 15 times that for a sphere, for the models used. The results are relevant to the formation of shaleding layers at the upper level of thunder-

17rd lonic interactions and processes field-confedited found changing of ICE CRISTALS

shielding layers at the upper level of thunder-clouds. The measurements also provide estimates of a parameter (August to especitan-ce; that controls the rate of growth by subli-J. Gesphys. Pen., Green, Paper 8001710

STRUCTURES OF ACMOSPHERIC PRECEPITATION SYSTEMS—
STRUCTURES OF ACMOSPHERIC PRECEPITATION SYSTEMS—
A GURAL SURVEY
S. A. House, Jr. (Department of Atmospheric Sciences, University of Maskington, Seattle)
A survey of atmospheric precipitation systems, taging from mid-leitude cylones and thunder—
storms to tropical cloud clusters, burricanses and sourcess, showe that all these systems are well described in terms of the rather traditional concepts of systellows and conventive precipitation, in attackform precipitation, see particles grow as they drift deserved from high levels and pass through a well-defined selting layer. In conventive precipitation, particles begin growing at low layers and are carried opened by strong

updrafts and fall out in intense verticallyoriented showers. Hodern observations show
that nii the major types of precipitation observed over the globe can be and often are combinations of these two basic types of pracipitation. Extratropical cyclonic pracipitation is
basically stratiforts; however, it is typically
intensified in regions called rainbands. Some
tainbands are highly convective features, which
move through the basic stratiform pracipitation.
In other rainbands, shallow convective calls
occur sloft and halp to exhance the basic strariform pracipitation, mid-latitude thundarstorms and tropical precipitation systems are
basically convective, however, stratiform pracipitation can develop in their mid-to-late
stages of development. This type of stratiform
pracipitation, which can become quite extansive
in both tropical and ind-latitude systems,
apparently arises so groups or successions of
active convective calls leave the particles
shoft to settle downward gradually after the
cells' updrafts die out.
Rad. 5:1., Japan 803174) Rad. 5:1., Paper 8031743

Mineralogy, Petrology, and Crystal Chemistry

4250 Mineral occurrences and deposits. MARGARITE PSEUDOMORPHS AFTER KYANITE IN GLEN ESK, SCOTLAND.

Emm. Baltatzis(Institute of Mineralogy and Petrology, The National University of Athens, Pamenistimiopolis, Ano Ilimaia, Athens(621), Greece) and C.Ratagas.

Description of a new occurrence of Margarite in a graphitic queles near Pattercairn village, Glen Esk, Scotland, Margarite Occurs as pseudomorphs after Kyanite and contains considerable paragonite component in solid solution (~25.5 mole %). The data presented enable establishment of another tie line on the white mica plane of the system AlpO3-CaO-Na2O-K2O-8102-H2O. (Margarite, pseudomorphs, Glen Esk, Scotland). Amer, Mineral

Particles and Fields-Interplanetary Space

5340 Shock waves MICROINSTANLITIES UPSTREAM OF THE EARTH'S BOW MICROINSTANLITIES UPSTREAM OF THE EARTH'S BOW MICROINSTANLITIES UPSTREAM OF THE EARTH'S BOW MICROINSTANLING A REPORT OF CALIFORNIA, Los Alamos Scientific Laboratory, Los Alamos, NK 87545
This is a brief review of short wavelength fluctuations and their associated phonomens upstream of the earth's how shock. Sources of free energy, the most likely instabilities and the associated nonlinear consequences which may be observed are discussed.

J. Geophys. Res., Blue, Faper SOA1676

5370 Solar wind segmentic fields
INF SECTOR BEHAVIOR ESTIMATED FROM THE
GEOMAGNETIC DAYA AT SOUTH POLE
5. Matsushita (High Altitude Observatory,
WAM, Boulder, Colorado 80307) and W.-Y. Xu
IMF Sector behavior which has previously been
estimated from the yecomegnetic data at Godhavn
is confirmed by the Study of the data at South
Pole for 1959-1970 with the same estimation
technique, taking the difference between northern
and southern hemispheres into consideration. A
mathod to Improve (about 185) the agreement
between assigned and actual sector structures by
the study of the data at the two stations is
supposed. Geomagnetic disturbance effects on
sector estimation are discussed, and reversed
emphasis. emphasis. J. Coophys, Les., Blue, Paper BOA1638

of Asses, theory
hasofu
as extend is made to interpret solar wind
waristices observed at the earth's distance,
usely the solar cycle variations, the suniassust variations, and the 27-day variations, as
well as the polarity changes of the interplanetely sugestic field, mainly in terms of two
effects, a positive instrudinal gradient of the
calculated appeal and a vobbling solar dipole, effects, a positive latitudinal gradient of the solar wind space and a wobbling solar dipole, sometimed with the annual (hellospharic) latitudent exception of the marth. It is shown that a significant pare of the solar wind variations observed at the marth-of distance and the changes of polarity pattern of the interplanetary magnetic field can be reasonably well reproduced by the markets.

Particles and Fields—

5180 Salar wind plasma A CAUSE OF SOLAR STREE SPEED VARIATIONS OBSERVED

J. Geophys. Res., Blue, Paper SCAL698

ionosphere

3300 Mirglow
TRK OII(7)20-30Å) AIPGLOW; A HORPHOLOGICAL STUDY
J. H. Yes (Space Physics Rassarch Laboratory,
Intwrsity of Michigan, Ann Arbor, M 48109),
V. J. Abrau and P. B. Rays
A statistical study of the 7020-30Å (0*(2*p) 0*(20)) sirglow was conducted by analyzing the
data taken from the Visible Airglow Experiment
(VAR) or the Atmosphere Explorer (AE) satellites
C and E during the time periods between 1974
and 1979. Averaged column sminsion rate profiles
an a function of solar smalth angle and solar
setivity veriation are presented here. The galastic background has been carefully subtracted.
The result shows that the rate of decreasing
seission as a function of solar sonith angle
serses with the theoretical calculation based agrees with the theoretical calculation based upon a neutral atmosphere model and the solar appetrum as measured by the EUV spectrometer appetrum as measured by the total particular of the Atmosphere Explorer metallite. Further sere, an expected increase with solar activity the appeared in a plot of emission brightness

CAL SIMULATIONS OF ION ACCOUNTS DOUBLE r. Acto and H. Okuda (Planna Physics Laboratory, Princeton University, Princeton, N.J. 08544

versus soler 10.7 cm flux. J. Geophys. Ros., Blue, Paper 80al 590

Princeton University, Princeton, N.J. Obset U.S.A.)
A comprehensive numerical study of ion accountic double layers has been performed for both periodic and non-periodic systems by means of one-dimensional particle simulations. It is found that the number of double layers and the associated potential jump across the system increases with the system length. The potential jump across as single double layer is skyly along the separation between two consecutive double layers in typically 1000 Debye length. Fixman heating one has as large as 15% of the original temperature due to the double layer induced accellance resistivity. The double layer induced accellance resistivity. The double layer information. (Double layer, ion-accountic instability, electric field).
J. Geophys. Res., Blue, Paper 80A1767

5515 Auroras MODULATION OF STABLE AURORAL RED (SAR) Age Occumence margs
D. W. Slater (Pacific Northwest Laboratory
Space Sciences Div., P.O. Box 999, Richland, WA.

D. W. Maler (Pacific Northwest Laboralory pice Sciences Div., P.O. Boy 999, Richland, WA. 9352) and L. L. Smith

A Corprehensive search of Stable Auroral Red (SAP) are occurrences during the period covering plant cycle 20 (1968-1978) using data collected by Photometer's logisted at Richland, Mashington (As. 197, 240.481) has yielded a large data bace by which to examine occurrence rates. The present paper has identified two major modulations of this rate. It is established that the SAR are occurrence rate displays a phase lag of approximately 2 or 3 years when compared to the solar cycle activity as determined by sunspot numbers. Additionally, a rather distinct summertime/annual minicus of occurrence frequency is demonstrated inorthern hemisphare summer). A compendium of those event identified from the Richland Observatory is presented. Current SAR are identifications (into 1980) support these findings. J. Geophys. Res., Blue, Paper 80a1731

5915 Auroras
FOLAN CAF F LAYER AURORAS
E.J. Weber (Regis College Remearch Center,
Weston, NA 02193) J. Buchau
Folar cap surcrass were measured at Thule Air
Base, Greenland in December 1979, using an all
sky imaging photomater. These images, ucumbined,
with digital ionogonde measurements, show the
orientation, attructure, and drift motion of sunmilgoed, F Layer surcras. Drifts in both the
dawn-to-dual and dusk-to-dawn direction were obmerved. These auroras were not visible on the
sall sky camera films; however, coincident Defense
Meteorological Estellita Frogram (IMEF) precipitating electron measurements show that these
arcs are produced by Fluxes of low energy
(PriDO et) electrons. Simultaneous satelliteto-ground signal asplitude measurements show
that these surcrass are accompanied by he scale
size iomogharic irregularities, which cause
strong amplitude Thuttantions (scintillation)
on the received satellite signal. (Polar cap,
auroras, joiar cap F Layer, scintillation).
Geoghys, Res. Left., Paper SOL1745

5540 Ion densities and temperatures
THEORITICAL PREDICTIONS FOR ION COMPOSITION IN
THE KNOWLASTITUTE COMPOSITION IN

cophys. Res., Blue, Paper 8041732

Second Seasities and temperatures

THENDITICAL PREDICTIONS FOR ION CONFOSITION IN

THE HIGH-LATITUDE WINTER F-REGION FOR SOLAR MINI
HUM AND LAM RACKITK KETIVITY

J.J. Sola (Center for Atmospheric and Space Sci
soles, Utch State University, Logen, Utch 84322)

W.J. Patt and S.H. Sobunk

We trobled a simple plasma convection model

with an ioncapheric-atmospheric density model in

crider to study the ion composition in the

firm ion study the ion composition in the

firm ion study has been composition in the

firm ion study has been composition in the

firm ion study has been composition in the

firm in seconagnetic activity. Our numerical

study produced time-dependent, 3-dimensional, ign

gasly distributions for the ions MO', O', N',

o', w and Ma'

He covered the high-initided in

nosphers May. He covered the high-initided in

form the second of the composition of for a time pariod

that complete day. From our study we found

that composition with latitude and at al
ficant veriation with latitude, loud time, alti
tude, and universal time (2) The veriations of

are in pool agreement with the Atmosphere Explor
tively; (1) it times and at cartists constions the

molecular ion density can be comperable to the O'

density at 300 km, and at 200 km the O' density

can be comprable to the molecular ion density.

Interpretate have important implications for the

fround-based observation sites thould measure

fround-based observation sites thould measure

fround-based observation steen thould measure

fround-based observations in both alvatrop densi
y and ion composition, again data to first

orbit to not repretations in both alvatrop dansi
y and ion composition, again data to first

orbit on oth verificancy along the track

of a matality in a highly elliption good of the plant

tions.

1. Geophys. Res., Blue, Fayar GhA1712

9300 Particle procipitation MORNING SECTOR ION PRECIPITATION FOLLOWING SUBSTORM INJECTIONS Side Particle precipiention

MORNING SECTOR ION PRECIPITATION FOLLOWING

SUBSTORM IRRICTIONS

J.A. Sauwaud (Centre d'Etude Spatiale des Payonmements. CPSS-Université Paul Substier, 11029

Toulouse Cédax, Francel, J. Craenter, K. Mousia,
R.A. Foyvarshkin, N.V. Jorjio

The suroral ion measuraments (0.4 - 30 kmV)

made from the polar satellite Aureol-1 have yovesied two types of pracipitation with different
energy characteristics in the suroral and subauroral inghitime none: 1) in the matire nighttime auroral some a proton pracipitation with an

average ranging from "5 keV to at least 23 keV,

Which calumides with the region of ouroral Belice
sarfeelites anission as observed from the ground.

The large scale characteristic of this procipitarion caflects the adiabatic acceleration of the
protons in the plasmasheat and their drift noclens in the outer magnetosphere (Galperin et al.,

1978). 2) A subsuroral precipitation of lons

with nargy less than 12 to 19 km Vinited to the
morning sector between approximately 00H and 05
00H MLT. This peobly observed structure is sporadic and takes place in the boars following the
injections of plasmasheat particles into the lu
mar magnetosphers at the onset of magnetospheric
substorms. The tonospheric region affacted by the
pracipitation corresponds, in the squatorial plams, to the some in which altwin layers result
from the ion drift pattern (from the added affac
ts of convection and corotation electric fields
and from magnetic field gredient). It is shown
that the electric and magnetic fields models darived by Mc Huwin (1972) from the energy disperaion of the particles injected at the Mg at the
substorm onner ecounts for the main sparial and
anergy characteristics of this low-energy ion
subsuroral precipitation.

This result is obtained by excanding the logic
used to a study the proton "magnet on the half in order is an energy disperaion of the particles injected at the M inner
magnetosphare and this makes it possible to obLain, from the injection

556) Plauma motion, convection, or circulation MODEL EXCEPAGES OF THE RINCED PLANETS J.G. Lubmarn (Institute of Coophysics and Plenotary Physics, University of California, Los Angelos, CA

J.G. Lubmann finations of Goophysics and Planetary Physics, University of California, Los Angelos, CA 9024) and R.J. Walker

The theory of rotating ion escapheres in dipolar magnetic field geometries is used to predict some passible effects of the rings on the inner planeaphysics of the ringe planets Jupiter, Saturn, and Uranus. Planea escapheres consist of four types of particles that intersect the exchasm in either heatisphere, 2) trapped particles which trajectories that do not intersect the exchasm in either heatisphere, 2) trapped particles which travel from the exchange particles which similarly errive at the sociation of the conjugate exchasm, and () incoming perticles which ministry errive at the sociation of the conjugate or whose, The anniverse carried out therein assumes a partely ionespheric nource. It is found that if the rings affect the trapped plasms only, the cold plasms density at Saturn is either reduced or increased by a factor of 12 at 1 = 1.65, dupending as whather the ring popularies or suprices to the rapped trajectories. The lossepheric plasms density at Uranus similarly depends on the properties of Uranus' rings. At Jupiter, however, ionospheric particles in the inner plasmaphere are primarily on ballistic trajectories which do not intersect the rings except possibly at longitudes where the rings are far from the magnetic equator (due to the non-dipolar ungnetic components of Jupiter's field). When the properties of the rings as sources and einke of loss are more accurately determined, these conclusions may have to be altered. However, it is found that if all cold plasms perifics on trapped orbits are absorbed and the rings are not a source of plasms, this simple exception theory can explain the longapheric density profile inferred from the Pionear il Saturn radio occultation appariment. In which a localized pash in the profile

5503 Places notion, convection, or cir-

Colorion

Polar Cap Placks FLOW 187FY REGION

F. Prindabl, I.G. Prixdahl, and

F. Dpangelev, Danieb Space Research

Institute, DK-2800 Lyngby, Denbark

A region of bigs pleans flow velocity
centered about none exist is the dayside auroral oval, and is indicated by
the URC (Slant I Condition) plasma
instability features seen on incomosals
recordings. The delty SEC distribution
ourves at Godhavn (77.5' inveriant
latitude) and for all Kp show virtually
no shift in local time for a change of
eign of IMF B.

A apparation of the data into Kp > 1
and Kp = 3 above no shift is local time
corrolated with B. for Kp = 3 where the
ionospheric sounder at Godhavn power
under (or south or) the cusp. For Kp >
3 the sounder moves inside the polar
cap and the SEC distribution curves
show a small B.—dependent shift in the
same direction'ss the shift is the dentral place cap of large electric field
and high flow velocity.

This suggests that the plasma flow in
and equatorward of the throat region is
independent of the polarity of By.

J. Geophys. Res., Slue, Paper SOM1701

Particles and Fields-Magnetosphere

5720 Intermediate between solar wind and segmete-EDINGTO THE PROPAGATION OF UPSTREAM PROTONS BETWEEN THE THE PROPAGATION OF UPSIGNATOR PROPAGATION OF UPSIGNATURE BORNESS AND ISSE-J T.R. Sandarson (Spece Science Department of SEA, ESTEC, Noordwijk, The Hetherists) R. Peinhard and K.-P. Wenzel We present a detailed analysis of a sartes of 5

and K.-P. Mennel
We present a detailed amelysis of a sartes of 5
we present a detailed amelysis of a sartes of 5
a cos hour time period on 11 october 1978. The cha
a cos hour time period on 11 october 1978. The cha
acrossince were made by the low-energy proton instrucent on 1925-3 which is designed to measure
threa-dimensional aminotropies in the energy
range 35-1500 keV. We have estead this particurange 35-1500 keV. We have estead this particular merios of events from the large number of uptraces years of events from the large number of uptraces years of events of the position of
stream years are structured to the position of
stream quiet and the dimensionistics of the propagation of upstream protome were unneasily clear. We
seemise in detail the intensity profiles and proparties of the amisstropies of particular interspeccoraft enters or leaves a privile populated
assumptions of the directions of the gradient
rangion. Analysis of the directions of the gradient
rangion. Analysis of the directions of the gradient
reasis that upstream protoms propagate in chasts
(upstream protoms, anjustropies).

J. Geophys. Res., Elue; Paper 20041716

STAL Magnetic bill
THE DVIAB HAMPITOTATL AND ITS COMMENT AMEET
THE .W. Remanach (ASSA/Ocddard Space Filthe Conter,
Laboratory For Extraterrestrial Physics,
Laboratory, No. 20(71) L. F. Dirings and W. F. Sens,
Ambigues of Yopeker generatic field measurements
have extended pure impair channing of the structural

of a places much and subschied "neutral" thest. In the region of the tail where the sheet is ob-tured, the variation of the magnetic field as a retuit of the sheet structure and its 10-hr periodic notion is the dominant variation scen-tionies of both the large-reals configuration of the ourset thest wheel as a surface and of the internal structure of the sheet and its crients-tion indicate that the displaces and 10 % in the internal structure of the anest and its crientation indicate that (1) at distances 2 30 F, in the
tail the sheet is oriented within 10° of the
Jovian equatorial plane, nost likely as a result
of the solar wind interaction with the Jovian
magnetosphere; (2) the surface power north and
youth within an amplitude of several F, with
respect to that planes and (3) at large distances
this motion is primarily due to a racking of the
ourrent sheet about the Jupiter-Sun line. A
mathematical code that takes the tot is geometry
into account provides a simpler description of
sheet ration in the deep tail than models based on
actis symmetry. The planes sheet in the tail is
estimated to have an average thickness / 5 F,
(Regnetotal), current sheet, magnetosphere,
Jupiter).

Jupiter). J. Goophys. Res., Blus. Paper 80A1718

5742 Megnetosheelh JUPITEP'S MAGHETOPAUSE, BCM SHOCK AND 10-HOUR MODULATED MAGHETOSHEATH: VOYAGERS I AND 2 1. P. Lepping (Laboratory for Estrateriestrial Physics, MASA/Godderd Spece Flight Center, Greenbeit, HD 20771) L. F. Burlaga and L. V.

Elein
This summery report discusses Jupitor's This summary report discusses Jupiter's magnotopause, Dom shock and magnetosheath, based on fine scale magnotic field date from the toyager 1 and 2 encounters. Expiscit musein of the demnate magnetopause and bow shock in Jupiter's orbital plane copply an assymetric persons and how shock in Jupiter's orbital plane copply an assymetric persons and hyperbole, respectively, and satisfy swerage boundary crossing positions, intowns and outbound; these nodels are determined separately for the two encounters. Average negatopause sormals, estimated by minious verlance analyses of the field, generally satisfy the sodekparabols to within a faw degree, except for the tyosger 2 outbound crossings. A new phenomenon has keen discovered in Jupiter's magnetosheath. It is manifested as 15 or) 10 hour quest-periodic modulation of the direction of the magnetic field in the outbound magnetosheath, predominently in the morthward (N) and southward (S) directions. It was seen to occur during both encounters and appears most evident in Yoyager 2 authours observations. The durations of the N f C transitions range from tens of minutes to 53 hours. These transitions cour in a plane parallel to the local rodel magnetopause location. These alignmures may be due to magnetosheath fleid line draping codulated by the large scale notion of the magnotospheric plana slight. Geophys. Res. Lett., Paper 801193

5761 Plantipage
NYDROHAGRETIC WAVE OBSERVATIONS IN THE VICINITY NIDERINGSHIE WAY - "SSEAT LESS IT IN THE THE TOTAL OF A MACHETOSPHERIC PLASMA DENSITY CRADIL!

L J. Lanterstil Bell Liboratories, Burray Will,
S.J., U79741 and A. Wolfe* Data from the Boll Laboraturies magnetomoto Data from the Boil Laboratories dispersored receives in the Northern heatisphere are naived Juring a reported passage of the 15EF-1 and -2 spaceraft through the same local time sector is the ground-based stations. The ground-based data indicate that downtown by the ground-based data indicate that downtown by the ground-based data indicate that downtown higher with decreasing radial distance iderransing latitude on the Earth's surface), so was also indicated by the data executed along the smaller of tack. Further, a surface), as was also indicated by the data recorded along the marallite track. Further, a wave resonance identified in the ground-based data occurred at a charp density gradient in the magnetosphere please, as reported from ISEE particle experients. The theoretical conditions for existence of this resonance are consistent with the matellite trassurements of significant fluxes of Z · 1 tons as contributors to the magnetosphere please population at this time. (Magnetosphere, Alfvén Majon). 30.1639

3763 Plasmapause
PANCARE PITCH AUGLE DISTRIBUTIONS IN WARM IONE
OBSERVED WITH ISER-1
1. L. Barvitz, (Department of Physics, The
University of Alabams in Eunswille, Buntswille,
Alabams 35699) C. R. Baugher, C. E. Chappall,
E. G. Shellsy and D. T. Young
Observations of panesha (yeak firm mear 90°
pitch angle) distributions of low-energy
(5 100eV) Ions are reported. Fangake distributions octur often in H° and HC simultaneously while 0° firmes are either undetectable
or field-aligned. These H° and Hc⁺ panesha

Honor Your -Colleagues The Waiter H. Bucher Medai Committee

This committee, chaired by Bryan L. Isacks, is seeking ominations for this award, which is given in odd-numbala. ears, for original contributions to the basic knowledge of te earth's crust Leiters of normnation and supporting materials should be sent directly to feache at the Department of Geological Sci-onces, Cornell University, lihaca, New York 14850 The citation and acceptance for the 1979 Bucher Medalis

Edward Irving, were published in the August 14, 1979, issue

1972 William Jason Morgan 1974 Maurco Ewing 1975 Lynn Sykes 1977 Bruco C. Heozen

DEADLINE FOR HOMINATIONS IS JANUARY 15, 1981

distributions typically display characteristic energies of the order of 10eV and are frequently mixed with higher density, colder (AT 5 leV), isotrapic, quasi-theresilian components. They appear often within the outer regions of the plansuphore, and seem to occur most frequently on the dayside and near the magnetic equator. 1. Geophys. Res., Blue, Paper 80A1760

SIJO Short-pariod (loss than I day) rectations of magnetic field RELIPTICITY VARIATIONS IN PER PULSATIONS AT 104 Activors

P.R. Sutcliffe (Magnetic Observatory of the CSIR,
P.U. Sou JJ, Hereshou INO, South Africa)

A study of the temporal variations in the horizontal pleas alliquicity of P12 pulsation formed at a low latitude station reveals both moctoases from positive to negative through the ctourse from positive to negative through the night; the greatest decrease occurs during No-verbor and the smallest during May. The verte-tions orbidit trends similar to those in plantam-phorts, electron Jensity and track immaphetic clustran content. (Pi) pulsations, polarization,

5770 Short-period Class than 1 day) variatious

ulliplicity, plasmampherel.

5770 Short-period (less than 1 day) vertations of magnetic field SPECTRAL (MRACTERISTICS OF MAGNETIC FI? PULSATIONS IN THE AURORAL REGION AND LUXER LATITUES.

M. Emerchipa (Faktoba hardestic Observatory, 54%, Rakioka, Yasato-macht, Mitheri-gum, Ibarahi 315-01 JAFAB) and T. 5aito.

The spectral characteristics of magnetic Pt? pulsations are studied using data obtained simultaneously over a wide latitudical range from the auroral region (I-2.5) through low-intitudes (I-1.8). The Pt? perfod, which is commonly observed over the wide latitudinal range, shows a close relation to the position of the associated surversi breakup. It between shorter (longer) when the surveysh breakup starte at lower (higher) latitudes. The observational results substantiate well the constant oscillaat lower (nighter) lattices. It is considered ascilla-results substantiate well the torsical ascilla-tion model which suggests that PI2 is caused by the torsional hydromagnatic oscillation of the geomagnatic field line anchored on the surges! J. Geophys. Bes., Blue, Paper SOAIS91

Physical Properties of Rocks

SILO Elasticity, fracture, and thow EXPERDICEMAL HIGH TEMPLEATURE AND HIGH PRESSURE FAULTS
Glencore, L. Shelton (Department of Geological Sciances, Stown University, Providence, Rt 02912)
Jen Tullis and Tatty Tullis
Deformation experiments on Male mibits rock have produced faults at 5 to 15 kb confining pressure and 700° to 1123°C, when hydrolytic weakening is suppressed by either the absence of water of by low pressure. The faults are characterized by: 1 is a magle of short A5° to 01, 2) very little gouge, and 3) several percent fermanent strain before failure. Temperature dependent friction is believed to glow frictional eliding and faulting at arreases below these predicted by the Coulosh failure criterica, but above those of hydrolytically weakened crystel plantic flow. High confining pressure, low friction and reduced tempile strass concentrations may allow the feet to propagate as a shear rather than a tempile crack. (faults, water, high pressure).

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JANUARY 6, 1981

Planetology

this Altergraph of Planets
THERMAL STRUCTION AND DIRANICS (F THE JOSIAN
ATMOSPHSE I. THE CERAT SED SPOS
F. N. Flasher (MASA/G-dard Space Flight Center.
Crantable, M. Pretch and F. Glarash
Temperatures and through which, durined from
Voyage 1825 data over the Great Ped Spot and its
environs, are presented. The atmosphere over the
GBS in characterised by a tropopause which is cold
relative to its environment and an open stratoapters which is relatively warm. The mold
tropopause implies a decrease in anticystonic
vorticity with reight above 500 mb through the
lower stratographs. USES observations at 500
indicated little emission from the GBS Staeff, but
encanted emission to a rire about it, in agreement
with resent ground-based results. The behavior of
the tropopause and 500 temperatures can be
consistently interpreted as resulting from a
circulation which rises within the GBS and
aubsites in the area broad it. The applanation
of the upper stratespheria beaperatures is not so
abraightforward. A presidue suggestion that they
may be a manifactation of the linear verbical
propagation of Reseave waves appears teccnosistent,
which the gross estativest symmetry in the stratoappears temperatures can the GBS. The
implications of the present results for various
theoretical models of the GBS are stumined, and
the possibility that latent hear release drives
the GBS is discussed. Symmical scalings based on
an asiagementic, frictionally controlled vortes
alegest tent, assis from the monitonerature
kennets are finear as distingt from the orter troptest dystone, which are markedly a J. Geopt. . Res., Green, Pager &G. 1781

6510 Atacopheres of Finnets
THERMAL GENETITES AND LYMINGS OF THE JUNIAN
ATMORPHE II. VICISE CITED FEATHER
D. Courath HASA/Godinal Opera Flight Center.
Greenbeit, MD 20711) F. N. Finner, J. Fireglia,
P. Giseath and C. Hant
Investigation of the thermal attriture above
soluted clost deathers in the Jusian atmosphere,
sabing use of vayager INIC date, reveals strong
similarities mong a bind rarge of features which
differ casiderably in visual appearance. The
atmosphere above entirelistic features, including
the sajor white ownic, the Great ped foot, and a
some, are cold relative to the immediate surroundings in the upper trop-sphere and troppasse
region. These regults are consisted with upwelling and divergence in this part of the shoop
phare. In contrast a bind spot, and a "barge",
which are localized with accompanying convergence,
is all custs, the thermal wind about merchadings,
implying subsidence with accompanying convergence,
is all custs, the thermal wind about merchadings
interest from the observed temperature perturbasinterest from the observed temperature perturbations ingly an upper limit of vertical mixing
times mear the trapopause of vice vicinities
interest from the observed temperature perturbations ingly an upper limit of vertical mixing
times mear the trapopause of vice vicinities
interest from the observed temperature perturbations ingly an upper limit of vertical mixing
times many them are candidarship sprintion.
At the general time of existency beginnerion
for this behavior appears to only 1. Correlate behavior appears to exist

J.G. Luhmann (Institute of Geophysics and Plane-tary Physics, University of California, Los Angeles, CA 90024 USA) B.C. Siphic and L.R.

The occasions observation of large scale horisonal magnetic fields within the dayside ionspects magnetic fields within the dayside ionsphere of Venus by the flungate magnetomater on the Plonesy Value Orbiter suggests the presence of large scale current system. Using the manufacture and the saction density and temperature, together with the previously reported neutral strasphere density and carposition. It is found that the local lomosphere can be described at these times by a simple myfel which treats the unobserved electric field as a perameter. When the model is appropriate, the sittenday profiles of the ion and electron velocities and the currents along the satellite insjectory can be inferred. These results elucidate the configurations and sources of the ionesphere current systems which produce the observed large scale magnetic fields, and in particular fillustrate the effect of ion-pautral coupling in the determination of the current systems at low attitudes. aystem at low altitudes. J. Geophys. Pes., Blue, Paper SGA1628

6510 Atmospheres of planets
OSCILLATIONS AND VILOUITY STRUCTURE OF A LONG-LIVED CYCLORIC SPOT
A. Battes, D. Weskert, A. Ingersoll, E. Danielson
[California Institute of Technology, Division of Geological and Planetery Sciences. Passadess, California 91125]

Goolegical and Planetary Sciences, Temadens, California 91123]
Duth brown cyclonic spots ("harges") at 140 M were studied using Voyagar 1 and 2 images of Jupites. Movie sequences were ande to study the spots' behavior over intervals of 30 days and longer. These works revealed that the length and widdth vary by 19% with a period of about 15 days, while the area remains approximately constant. The horizontal valacity field was investigated for an interval of about one day. Plow around the largest barge (feature 6) occurs as a ring current. The vorticity inferred is about two and one-half these that of the ambient two and one-half these that of the ambient cyclonic sunst circulation, and about one-half the value of the local planetary vorticity. Length and width variations uppear to be associated with a man-sare borisontal divergence field, if the accillations are an natural mode of the system, the 11-day period will provide an important datum for trating models of stable closed vortices. [Movie, onefficiency, vorticity, diversions].

diversions). J. Geophys. Res., Green, Paper 2001753

6440 Interior of moun itentonics, force fields, composition, etc.;
STRUCTURE OF THE INCAM CRUST AT MIGHLAND SITE APOLLO STATEOM 16
LIBERT AND 16
LIBERT AN

linear particle notion expected for the onset of these body wave strivels in the scattered code of funds estanograms. The remuits of this work tantatively indicate that the highland site at station 16 has a 75 km thick crust with an inter-mediate 20 km interface, compared to the 60 km station in hose a 73 hm thick crust with an inter-mediate 20 km interface, compared to the 60 km crust and 20 km interface in Geessus Procediarum, a mare region. Since the 20 km upper crust appears to smist at both highland and mare sites, it probably does not represent a mare beast layer but rather a more general feature of the crust. Crustal thickness may partially control elevation be inesten. by isostany. Georinys. Res. Lett., Paper 80L1582

Seismology

6970 SERUPTURE OF the CRUST and Upper REDITS CONSTRAIRTS ON THE SEISHIC MAVE VELOCITY STRUCT SERVERTH THE TIBETAN PLATEAU AND THEIR TECTOMIC

HOPLICATIONS

M.P. Chen (Naswachusetts Institute of Technology,
77 Massachusetts Avenue, Cambridge, MA 02139)

Me coubins observations of group and phase velocity disperation of Rayleigh waves, of the serve
form of a long period P, phase, of P and S velocities from unreversed Fefraction profiles Hasing
earthquakes, and of telessismic S-P travel time
vasiduals to place bounds on the select wave velcotty structure of the crust and upper mentie under Täbet. From surface wave measurements along,
the Täbetan grutach thickness can be from 55 kg to
85 kg, with coursesponding uppersont mantle shear
wave valcotities of about 4.4 kg/s to 4.9 km/s; respectively. The and S valcotities were deteras the footesponding uppersont mattle shear wave valorities of about 4.4 km/s to 4.9 km/s, respectively. The P and S wellotties were determined to be 8.1210 6 km/s and 4.810.1 km/s respectively the P and S wellotties were determined to be 8.1210 6 km/s and 4.810.1 km/s respectively using travel time data at these from earthquakes in and on the satying of 7lbet. Combining results, the scuetal thickness is sont likely to be between 65-80 hm with an average shear wave velocity in the upper creat less than 1.5 km/s. A synthesis of one P, wave form does not provide an additional constraint on the velocity structure but is compatible with the range of models given above. In contrast to observations obtained for eight earthquakes in the Himsings, measurements of both telsselsmin S and P wave arrival times for nine earthquakes within tibet show unusually large intervals between P and 8 compared with the Jerfreys-Bullen Tablous, thus the P and E valorities shanels to a great depth beneath Tibet. From the dependence of the selective and from the similarity of the measured P and 8 wellottles beneath the the and beneath shinded and platforms, the temporature and temperature and from the similarity of the measured P and 8 wellottles beneath Tibet and beneath shinded and platforms, the temporature title the Mobo beneath Tibet is compatible with being 250-300 higher than hameath the platforms is close to 500°C. Such a temperature could reach or exceed the solidus of the lower Guut. Simple one-disansional heat conduction calculations suggest that the testonic and volumino activity could be explained by the recovery of the geotherm main that the conduction calculations suggest that the see of the crust. If the distribution of redicative heat production alements were not concentrated at the top of the ground above the required small heat flow. Thus the idea of a third-tood crust in response to hopi contal short single of third-tood crust in response to hopi contal shortening is compatible. onlations. J. Gas-, Rad. Paper 8081768

Circulation in the Coastal Ocean, Part 1

G. T. Csanady

Woods Hole Oceanographic Institution Woods Hole, Massachusetts

Introduction

Although the typical depth of oceanic basins is 5 km. a significant fraction of the earth's surface is covered by a much shallower sheet of water (only about 100 m in depth). In addition to many small lakes and lagoons, this includes extensive areas, with horizontal dimensions of 100 km and more, such as the Great Lakes, continental shelves, or large pulls such as the Gulf of Maine or the North Sea. These relalively large bodies of water behave dynamically in an 'oceanic' manner, in the sense that motions in them are strongly affected by the earth's rotation. They will be taken to constitute the 'coastal ocean,' a term that covers enclosed and semienclosed basins, as well as open seas such as the broad and flat continental shelves of the 'Atlantic' type or the narrow and steep shelves of the 'Pacific' type.

The dominant observable motions in the coastal ocean are rotary currents, which are associated with tides over continental shelves and with inertial oscillations in stratified, enclosed seas. Such motions, in what one might call a pure form, are characterized by the rotation of the current vector through 360° in a period not very different from the earth's rotation rate, and they illustrate the dynamical importance of rotation. Water particle motions during a full tidal or inertial cycle are along a closed ellipse of a typically longer axis length of a few kilometers, there being no net displacement in an idealized pure tidal or inertial oscillation. Of course, in reality there is always some residual motion, which adds up cycle after cycle and produces fluid particle displacements over the longer term that are much larger than the diameter of the tidal or inertial ellipse. Figure 1 illustrates oscillatory and residual motion by means of a progressive vector diagram of velocities observed at a fixed point in the Great Lakes. Although this is not the same as the path of a given particle of water that passes through the instrument, over a few oscillating cycles the correspondence is close enough for illustrative purposes.

The problem of 'circulation' is to describe and understand the pattern of the residual or longer-term water particle displacements. The distribution of important water properties. e.g., temperature, salinity, and the concentration of heavy metals or nutrients, and the transport of these properties, or of life-forms incapable of locomotion, depends critically on

This paper is the first of three parts. Parts 2 and 3 will be pub-



Editori A. F. Spithaus, Jr.; Associate Editors: Claude J. Allegre, Peter M Bell, Kevin C. Burke, Kristina Katsaros, Gerard Lechapelle, Christopher T. Russell, Richard A. Smith, Sean C. Solomon, Carl Kisslinger; News Writers Sarbara T. Shore; **208 Production Staff:** Sandra R. Marks, editor's assist ant; Eric Garrison, copy editor; Dae Sung Kirn, senior layout ertist; Patricla Bangert and Margaret W. Conelley, layout artists.

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Views expressed in this publication are those of the authors only and do not reflect official positions of the American Geophysical Union unless expressly stated.

Cover. Photograph shows the sawn interior of a 7.9-kg meteorite, Elephant Moralne 79001, recovered by the U.S. Antarotic expedition in 1978-79 and now part of the Antarctic meteorite collection being curated at the NASA-Johnson Space Center in Houston, Texas. The meleorite is apparently related to the shergotities, a rare group of achondrite meteorites comprising Shergotty, which fell in India in 1865; Zagami, which fell in Nigeria in 1962; and Alian Hills 77005, recovered from the Aniarctic in 1977-78. The relatively young ages of these them. of these three basaltic meteorites, less than 1.4 billion years, raise interesting questions as to whether these young ages date igneous events and, if so, whether that igneous activity took place on small bodies, such as the asteroids, where plausible heat sources are a problem, or on one of the inner planets where volcanism may have persisted throughout most of solar history. Cooperative studies by Several investigators will begin shortly on this new sample EETA 79001, which more closely resembles the shergottless than any othe meteorite group. It is also unique among known extratemental mate dals in showing an apparently undisturbed igneous contact between the pyroxene-rich main mass, to the left of the photograph, and the Pgeonite-maskelynite basalt at the right-hand margin. Dark greas, within the sample are patches and velicings of dark glass.

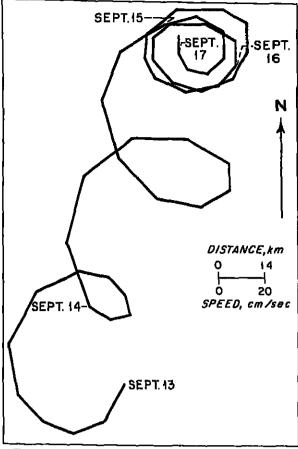


Fig. 1. Progressive vector diagram of 2-hour average currents observed at a fixed mooring in deep water in Lake Michigan. Motion consists of nearly circular inertial oscillation and northeastward resid ual drift. (From Verber | 1966].)

the pattern of circulation, but not very much on the oscillatory water motions, at least not in a direct way (indirect effects include, for example, the turbulence and mixing produced by tidal currents).

The study of circulation and mixing processes in the coastal ocean has received considerable impetus from the recent awareness of pollution problems which have been growing since the early 1960's. In some areas of the coastal ocean, major experimental studies were undertaken which led to an Impressive accumulation of observed facts and in some cases to a comparable increase in understanding. What we learned about the coastal ocean during the last 20 years certainly dwarfs previous knowledge and understanding.

It is not apparent that this greatly increased body of knowledge has so far had any significant effect on public debates of pollution problems and remedies. Perhaps those of us who have been involved in the great expansion of coastal ocean research should make greater efforts to make our voices heard. The present review is one attempt in this direction. Because our work on coastal circulation was clearly made possible by society's environmental concerns, it is appropriate to start with a discussion of this context.

The Coastal Ocean and Contemporary Civilization

Men have used the coastal ocean as a highway of commerce for millenia. The Mediterranean civilizations of the Greco-Roman world or of the Middle Ages would have been impossible without busy coastal traffic. Undoubtedly, some knowledge of coastal ocean behavior was required for safe commercial navigation. It is probably fair to say that the prosperity of many city-states on the shores of the Mediterranean. and later of the Baltic and the North seas, was built on the seafaring competence of the captains who commanded their merchant navies. Similarly, naval supremacy was critically dependent on an understanding of the sea, especially the coastal ocean. A good case can be made that the triumph of the British and Dutch naval forces over the Armada of the Duke of Medina Sidonia was not only due to superior technology but also to better acquaintance with the treacherous stretch of coastal ocean separating the British Isles from Eu-

At the present time, vessels of the limited size and endurance available to ancient mariners are still in plentiful use. although mostly for recreation. The 'aearch and rescue' mission of the Coast Guard protects this armada of small vessels, in support of which predictive models have been developed for the drift of disabled vessels. One of the key probtems in such models is to predict surface currents in the coastal ocean accurately enough to minimize time spent in 'search' in order to proceed speedily with 'rescue.'

Another use of the sea, the roots of which are lost in antiquity, is fishing, an industry that has traditionally sustained populations of teland nations such as iceland or Japan. Today, it is waitknown that the coastal ocean is the main Today, it is wait known that the coastal ocean is the main source of sealood, prime producing regions being, for example the Grand Saiks of Newtoundland or regions of coastal upwelling, such as the coastal ocean off Peru. Fishill dwestels life often observed to congregate near the outer boundary of the continental shelf, usually taken to be the 100m of 200m isoprath. Why should fishing be so good at the logic of the continental shelf? The answer no doubt depends on circulation and mixing in this region, which control the approximation and mixing in this region, which control the approximation and mixing in the region. trois the specify of nutrients to low-level life-forms. The economic importance today of the Grand Banks fishing region. and of similar highly productive regions of the coastal ocean,

needs no further elaboration. In contemporary civilization, the lessy of conflicting uses of the sea has arisen with some force. One of the contentious subjects is the dumping of waste in the ocean. From one point of view, the ocean is a vast blochemical factory which can recycle a variety of wastes produced by modern man into

'nonwastes,' i.e., compounds naturally present in the environment in some concentration. When discussing the disposal of such wastes, it is natural to speak of the 'assimilative capacity' of the ocean and to exploit it when ocean disposal is more economical than other methods. Two potential problems are immediately apparent; one, wastes may have undesirable effects before assimilation, e.g. while their concentration is much above normal background concentration; two, some wastes are man-made and may not decompose into naturally present substances for very long periods, if ever. Examples of such substances that are allen to the natural environment are plutonium or PCB's, which turn out to be toxic to various life forms. On account of the toxicity of these materials, their dumping into the ocean clearly conflicts with the traditional use of the sea as a source of food.

Today, there is a bewildering variety of waste disposal or. at any rate, 'relection' operations that have some antiaesthetic or polluting influence on the coastal ocean. The concentrated residue of New York City's sewage (sewage sludge) has been barged to an offshore site for the past 50 years or so. This site is relatively close to the New Jersey and Long Island coastlines, where the water is only about 30 m deep. In spite of the huge volumes of sludge dumped at this shallow site over the years, adverse effects could only be documented in the immediate neighborhood of this dump site. Even here, they were surprisingly mild. Clearly, the 'assimilative capacity' for sludge of this part of the coastal ocean is impressive. Most municipal sewage, however, enters the ocean closer to shore, at the end of outfall pipes, and the local effects are not always entirely acceptable. Some industrial wastes that are otherwise difficult to dispose of are dumped at deepwater sites (106 miles from New York and off Puerto Rico, for example) that are still quite close to the coastal ocean. Electric power generation involves the rejection of large quantities of heat, released in many places into the coastal ocean. The search for and extraction of petroleum over the continental shelf leads to the release of drilling muds and to some oil spills, although the latter are dwarfed by spills from large tankers.

Conflict in the use of the sea-and of the atmosphere, lithosphere, and other parts of the hydrosphere-has brought us the regulatory agency: in the United States, the Environmental Protection Agency, the Nuclear Regulatory Commission, and other bodies with similar powers. The task of these agencies is to resolve the conflict over uses to what one would hope is the greatest good for the greatest number of people. Not even the best friends of these agencies would claim that their decisions have in fact always been this wise One important cause of counterproductive regulation is ignorance; when the consequences of a given waste disposal operation are uncertain, there is a lendency to disallow such an operation, even when the available alternative waste disposal strategies have fairly serious adverse consequences A case in point is the near-prohibition of warm-water discharge into the coastal ocean in such cold regions as the Great Lakes or the Gulf of Maine. Several power companies have been forced by such rules into the construction of huge cooling-tower clusters. These are unsightly, their high cost contributes to the rising price of electricity, and most importantly, they cause local climate modification of a most undesirable kind, increased incidence of fog, clouds, icing of roads, which with statistical certainty kill so many extra motorists each year. It is difficult to imagine a scenario under which the simplest straight-through discharge of cooling water directly into the coastal ocean, even without any attempt to mitigate the effects of the heated water, would have com-

The greatest public attention has been focused on nuclear power, opposition to which has taken on religious overtones. Given the emotionalism surrounding this issue and our sensation-seeking media, this is one case where one sympathizes with the regulators in their attempts to base their decisions on reason. One alternative to a speedy development of nuclear power, including a system of breeder reactors, is continued reliance on oil imports from countries that are politically unstable. Other alternatives are no more desirable. As far as the coastal ocean is concerned, adverse effects of nuclear power are due to waste heat rejection, which takes place at a slightly higher rate than in fossil-fuel-fired plants; to the continued release of radionuclides at a low rate; and to the risk of catastrophic fallure, which would be accompanied by a much greater dose of radioactive release into the coastal ocean. The extent to which these corollaries of nuclear power generation affect marine life depends on circulation and mixing in the ocean, especially in the coastal ocean where all releases are concentrated. In the case of the proposed offshore nuclear power plants, the mainland would be protected by a 4.5km-wide moat, in which the transport and diffusion of suspended and dissolved materials would be of special interest.

parable consequences.

Retional regulatory decisions that concern conflicting uses of the coastal ocean should be based on quantitative models

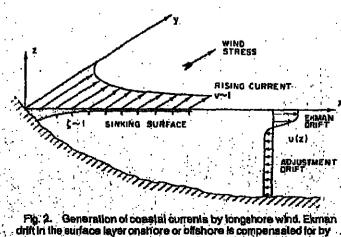


Fig. 2. Generation of coastal currents by tongshore wind. Ekman drift in the surface layer on affore or offshore is compensated for by mollons accompanying adjustment to geostrophic squilibrium. The fluid below the Ekman layer is accelerated in the longishore direction. by the Coriolla force of (cross-shore) adjustment drift.

that predict some agreed measure of nulsance or hazard associated with a given waste disposal or similar operation. The development of such models is a task of engineering science, which is outside the scope of the present article. These models, however, require quantitative inputs from various sciences, including the physical oceanography of the coastal ocean. In particular, a solid body of knowledge of circulation and mixing processes which is widely accepted by the scientific community is required. Otherwise, extravagant claims cannot be easily refuted, and reason becomes overshadowed by doomsday philosophy. On a rational level, the knowledge of coastal ocean physics is a prerequisite for a comparison of the consequences of oceanic disposal with the consequences of alternative disposal strategies.

Wind-Driven Transient Currents

The prime driving force of circulation in the coastal ocean is the wind. This is not always obvious in Ildal waters, but people living along the shores of the Great Lakes, for example, where tides are practically nonexistent, are well aware that wind action on coastal waters rapidly generates flow predominantly parallel to the coast. The coast prevents perpendicular movement, but longshore motion is unhindered and the longshore component of the wind is particularly effective in generating longshore currents and correspondingly long particle displacements.

One of the fruits of recent field studies and associated theoretical work has been an understanding of the structure and dynamics of such wind-driven nearshore currents. Earlier ideas came mainly from pioneering theoretical studies, such as those of *Ekman* [1905], which were based on various idealizations and usually applied only to steady state frictional equilibrium flow. However, winds at mid-latitudes are variable, rarely remaining constant for more than a day. Under these circumstances the transient properties of coastal currents are often of greater practical importance than their asymptotic steady state for constant wind. These transient properties depend more on inertial forces than on frictional ones, a fact which makes the Ekman-type models of limited use.

Inertial effects may be simply understood with aid of simple models in which bottom friction is supposed absent and a longshore wind stress is suddenly imposed at the surface. Any persistent longshore motion that arises must somehow adjust to geostrophic equilibrium, i.e., the Corlotis force associaled with longshore motion must eventually be balanced by an appropriate pressure field. Rossby [1938] first discussed such problems of 'geostrophic adjustment,' and Charnoy [1955] extended Rossby's work to coastal current generation in a two-layer ocean of constant depth. In Charney's quasigeostrophic model, the accelerating longshore current is postulated to adjust continually to geostrophic equilibrium. In reality, this may be expected to be true for periods of order f -1 and longer (f = Coriolis parameter). More complete calculations for simple closed basin or coastal zone models confirm that the response of a modest size sea (f = constant) to sudden wind stress can be regarded as a superposition of a quasigeostrophic (developing) coastal current and various long waves.

The dynamical principles involved in quasigeostrophic longshore current generation that are elucidated by these theoretical studies are illustrated in Figures 2 and 3. The surtace level perturbation and the longshore velocity increase hand-in-hand, maintaining geostrophic balance. In the longshore direction, the wind-stress impulse equals the depth-integrated momentum of the water column, as long as bottom friction is negligible.

The simple momentum balance in the longshore direction between the applied force and the increase of momentum in the water column can hold in the coastal zone because the depth-integrated Coriolis force associated with cross-shore flow vanishes. This is a direct consequence of the coastal constraint,' i.e., the condition that no water is transported in a direction perpendicular to the coast. The coastal constraint applies strictly at the coast, and to a high degree of approximation within some distance from the coast. The length of that distance is an important quantitative datum of each coastal ocean, characterizing its dynamical response and depending to a large extent on the depth distribution as a function of distance from shore. Generally, the coastal constraint holds a longer distance from shore over a flat shell than over a sleep shelf, but a number of other factors enter this question. In any event, the coastal constraint is often found to apply in water of order 100 m in depth.

In such relatively deep water, the force of the wind directly affects only a thin layer at the surface, the rest of the water column responds indirectly, through pressure forces generated by the displacement of water masses. Within the surface shear layer subject to direct wind action, turbulence governs the distribution of wind-imparted momentum, while the Coriolis force acts as an important modifier of the flow. A fur-

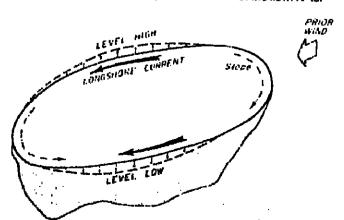


Fig. 3. System of coastal currents generated in a basin of simple shape by uniform wind. Geostrophic balance requires a rise of sea lovel along one coast parallel to the wind, a fall along the opposite

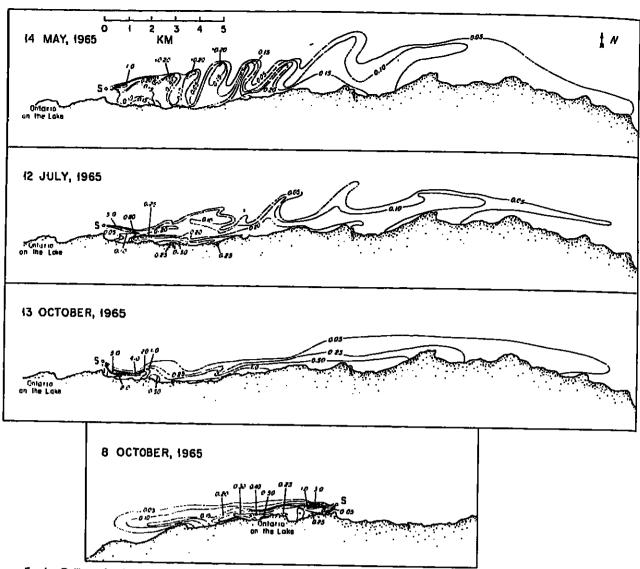


Fig. 4. Outlines of a plume generated by the continuous release of tracer dye from a nearshore source in Lake Ontario. Contours are fines of constant concentration in parts per billion (Pritchard-Carpenter, unpublished report, 1965; available from the authors, 208 Macalpine Road, Ellicott City, Md.). When the coastal current reverses direction, previously developed dye plume disappears through efficient mixing with ofishere waters.

bulent Ekman layer' develops, the depth of which depends only on wind stress and Coriolis parameter. At mid-latitudes, the typical Ekman layer depth is of the order of 10 m.

Within the Ekman layer, a longshore wind stress causes transport to the right of the wind." To satisfy the coastal constraint, a compensating return transport occurs, evenly distributed over the water column. Where the longshore pressure gradient vanishes, this return flow gives rise to an unbalanced Coriolis force, which accelerates the water alongshore. Similar cross-stream displacements are deduced in other geostrophic adjustment problems, and the phenomenon will be referred to as 'adjustment drift.'

Sea level gradients are generally not negligible in the longshore balance of forces. For example, in a closed basin, wind 'setup' is a well-known effect. When the wind blows along the longer axis of a long and narrow basin, such as Lake Erie or Lake Ontario, the level at the downwind end of the basin rises appreciably. In typical cases in Lake Erie, the level rise is of the order of a meter, a sufficient amount to affect the output of the hydroelectric power plant on the Niagara River.

In a basin of variable depth, 'setup' balances the wind only at the locus of the cross-sectional average depth. Shoreward from this locus, in shallower water, wind stress dominates and accelerates the coastal water mass downwind. In water much shallower than the average depth, the pressure gradient force associated with setup is negligible compared to the wind force, and the previous remarks on flow without long-shore gradient apply. In deep water, the pressure gradient dominates and causes return flow.

In a cross-shore transect, given a pressure gradient that opposes the wind stress, interior velocities of the developing quasi-geostrophic flow are similar to those shown in Figure 2. However, the cross-shore motion below the Ekman layer, which compensates for the Ekman drift, is now partly geostrophic flow associated with the longshore pressure gradient. Where the depth is equal to the section average depth, geostrophic cross-shore flow exactly compensates for Ekman drift. In much shallower water, the compensation (in the transient case) is mostly through adjustment drift. Longshore acceleration is only produced by the adjustment drift component.

The above theoretical framework of quasigeostrophic current generation has been amply confirmed by observations carried out in Lake Onlario during the International Field Year on the Great Lakes (IFYGL, carried out 1972–1973). At 5–10 km from shore, transient currents were found to have peak transports of a magnitude close to that expected from the wind stress impulse. The corresponding coastal-take-level rise was documented. Although the cross-shore adjustment drift was not evident in current meter records (which were dominated by stronger signals), they could be inferred from the displacement of constant property surfaces.

Quasigeostrophic longshore currents were also found to be responsible for a rather dramatic difference in current climatology in the Great Lakes between the coastal zone (of order 10-km width) and further offshore. Nearshore, water motions are mostly straight-line and shore parallel, further away they are dominated by inertial oscillations as already illustrated in Figure 1. Lagrangian tracer studies in the coast-

In the Northern Hemisphere. All other specific examples in this arlicie refer to the Northern Hemisphere, and the effects of the Cortolls force are discussed as they apply to those cases. In the Southern Hemisphere, of course, the Cortolls force acts in the opposite direction. al zone show long plumes hugging the coast in one direction or another (Figure 4). Tracer released more than 10-km ofshore moves in a much more erratic manner, i.e., in essentially all directions of the wind rose.

Lagrangian tracer studies also show the more or less complete disappearance of a tracer plume on the reversal of the coastal current caused by an opposing wind impulse. The adjustment drift is thus seen to perform the very important practical task of renewing the coastal water mass. For a strong enough wind impulse, the renewal is more or less complete.

Similar quasigeostrophic transient currents have also been well documented over continental shelves of the Pacific type. The continental shelf off Oregon has been the subject of intensive observational studies now for almost two decades. Much of this work has been oriented toward the understanding of the seasonal upwelling cycle and its biological implications, but a considerable amount of evidence was also accumulated on the dynamics of wind-driven transient currents. Longshore wind impulses were found to be associated with longshore current fluctuations that were distributed more or less evenly over the water column (below the surface layer). The coastal sea level rose and fell in step with such fluctuations. The presence of an adjustment drift could be inferred from the movement of the constant property surfaces.

Upweiling, Downweiling, and Coastal Jets

The distribution of water properties, salinity, temperature, nitrate and phosphate concentration, etc., is particularly sensitive to the circulation in a cross-shore transect because the streamlines of such circulation often cross sharp gradients. The gradients arise on account of the stratification of the water column that characterizes the coastal ocean in the summer season. A warm (and fresh, over continental shelves) layer of some 20-30 m overlies colder and denser water, and the region separating the two layers (the seasonal pycnocline) is relatively thin, so that it may often be thought of as an interface between two fluids of slightly different density.

in a stratified water column in static equilibrium, surfaces of constant temperature and salinity are horizontal. Cross-shore particle displacements associated with transient winds distort these surfaces in a characteristic way, depending on whether the cross-shore circulation is 'upwelling' or 'downwelling.' These terms refer to the upward motion of bottom water or the downward motion of surface water, respectively.

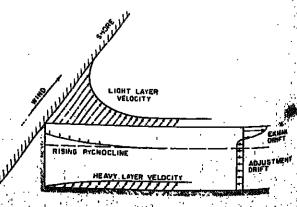


Fig. 5. Characteristics of rising coastal jet. Motion of pycnocilne is only significant in a narrow coastal band (typically 5-10 km wide).

Upwelling may cause those surfaces of constant temperature and salinity, which in static equilibrium form a pycnocline or relatively sharp density interface, to intersect the free surface. Conversely, downwelling may lead to the same surfaces intersecting the bottom at a depth several times their adulibrium depth.

As surfaces of constant density depart from their horizontal equilibrium position, horizontal pressure gradients arise in the fluid and affect the adjustment process to geostrophic balance and any resulting steady state of motion. A simple and realistic theoretical model consists of two layers of constant density separated by a frictionless interface. Charney's [1955] analysis dealt with this model and resulted in a quasigeostrophic solution for an infinite straight coast, constant depth, and suddenly imposed longshore wind on the assumption that the vertical excursion of the pycnocline is small ('linearized' theory). The principal difference between this and the homogeneous fluid case is that within a nearshore band only the top layer fluid responds to the wind by longshore acceleration, the bottom layer remaining quiescent. Consequently, higher longshore velocities arise in the top layer. At the same time the interface begins to rise or sink (depending on the direction of the wind) in such a way as to compensate for the surface level rise and to hold bottom pressure (nearly) constant. The strong surface layer current is then in geostrophic equilibrium with the horizontal pressure oradient associated with the inclination of the density interface and is legitimately called a coastal jet (in analogy with the atmospheric jet stream, which has a similar dynamical structure). The characteristics of a rising coastal jet are illustrated here in Figure 5.

As the coastal jet develops, the interface rises or sinks in a nearshore band of a width comparable to the 'internal radius of deformation,' which in typical coastal oceanic cases is 5-10 km. Far outside this band, the bottom layer moves bodily shoreward or seaward, while the top layer has to accommodate the Ekman drift in the opposite direction. Consideration of interior velocities then reveals a pattern exactly as if there were no density gradients, which was illustrated for a sloping beach model in Figure 2. Very close to the coast, however, there is little motion in the bottom layer. In the top layer, in the usual case when top-layer depth is about equal to Ekman-

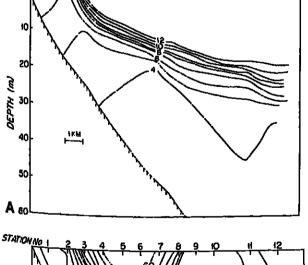
LIGHT LAYER VELOCITY

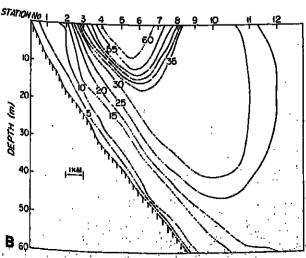
HEAVY LAYER VELOCITY

FIG. 8. Fully upwelled acceptable for the second second

Fig. 6. Fully upwelled pycnocline following a strong enough wind impulse. Light fluid has moved bodily offshore, and the boundary between light and heavy fluid forms a surface front some distance from the coast. The coastal jet moves out from the coast with the pycnocline.

2 3 4 5 6 7 8 9 10 11 12





region of Lake Ontarlo, observed during IFYGL, following strong wind impulse. Surface front is seen about 3 km from shore. (b) Distribution of longshore velocity (cm s⁻¹) observed on the same occasion. Core of the coastal jet lies between 4 and 7 km from shore. (From Csanedy [1977])

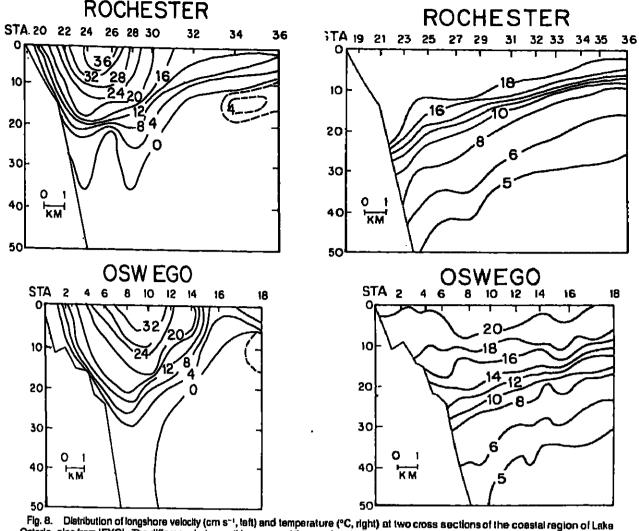


Fig. 8. Distribution of longshore velocity (cm s⁻¹, left) and temperature (°C, right) at two cross sections of the coastal region of Lake Ontario, also from IFYGL. The difference between this case and the previously illustrated one is that the volocities are here directed so as to have the coast to the right (i.e., point out of the picture), whereas in Figure 7 they point the other way, into the picture. Geostrophic balance of the coastal jet requires upwelling in the previous case, downwelling in this case. (Adapted from Csanady and Scott [1974].)

layer depth, cross-shore motions are negligible, and the force of the wind is evenly distributed over the top layer and causes uniform longshore acceleration. Where the top-layer depth is considerably greater than the Ekman-layer depth, adjustment drift occurs below the Ekman layer, but in the top layer

The most impressive results of upwelling and downwelling are the surfacing of isopycnals some distance from shore, or their sinking to a depth several times their equilibrium depth. The simple classical model, which postulates small vertical pycnocline excursions, does not apply to such cases. A strong longshore wind impulse is usually the cause of 'full' upwelling or downwelling events, with the large pycnocline displacements developing quite rapidly, often within hours or at most a day. It is reasonable to idealize these events by supposing that the wind impulse is evenly distributed over the top layer by vigorous turbulence. One may ask then how the two-layer fluid adjusts to geostrophic equilibrium following such an impulse, with interface and bottom friction neglected and the density of each layer separately conserved.

The extension of the classical theory on the basis of this idealization is relatively straightforward; it makes use of the principle of potential vorticity conservation [Csanady, 1977]. Quantitatively, the principal new result is that the velocity of the coastal jet is limited to a value about equal to the 'densimetric velocity' in the same way as maximum velocities are in certain 'critical flow' problems in hydraulics. The longshore momentum balance is completed by the Coriolis force associated with the bodily displacement (adjustment drift) of the entire top layer from shore to a distance of the order of a few kilometers (Figure 6).

It should be pointed out here than an offshore wind also causes upwelling and, if strong enough, may bring the interface to the surface. However, the flow pattern so generated is not in equilibrium without the wind acting, and the interface relaxes to a horizontal position on the cessation of the wind. Thus, in theory, the upwelling caused by a longshore wind is long-lived, an upwelling that is due to an offshore wind ephemeral. In practice, of course, dissipative processes cause the inclined interface that is in geostrophic equilibrium with a coastal jet to relax toward static equilibrium, but this is usually a slow process, with a typical time scale of 5 days or so.

Intense upwelling events are known to occur in a number of coastal locations, notably in the Great Lakes and along the Oregon coast. Early reports described the hydrography of upwelling, while later systematic studies, in the course of large-scale cooperative experiments, provided detailed information also on longshore and cross-shore currents [Smith et al., 1971; Smith, 1974; Mooers et al., 1976]. In the course of these investigations, some clearcut upwelling events have been documented. They were produced by a local alongshore wind impulse, and the observed properties of these events compared well with the above simple conceptual picture.

During the International Field Year on Lake Ontario, upwelling events in Lake Ontario could be observed with considerable spatial resolution. Figure 7 shows a well-documented event that occurred in October 1972. The wind stress impulse on this occasion was large enough to produce offshore displacement of a fully upwelled thermocline of some 3 km. The structure and intensity of the coastal jet, as well as the isotherm (= constant density surface) distribution, was very much as expected from the simple theoretical model described above.

el described above.

Examples of downwelling and associated coastal jets have also been documented in the Great Lakes. An example le altown in Figure 8, Trils also conforms in all essential aspects to the finite displacement quasignostrophic model.

Acknowledgments

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References

Charney, J. G., Generation of oceanic currents by wind, *J. Mar. Res.*, *14*, 477–498, 1955.

Csanady, G. T., Intermittent-full upwelling in Lake Ontario. J. Geophys. Res., 82, 397-419, 1977.
Csanady, G. T., and J. T. Scott, Baroclinic coastal jets in Lake On-

tario during IFYGL, J. Phys. Oceanogr., 4, 524-541, 1974.

Ekman, V. W., On the influence of the earth's rotation on ocean currents, Ark. Nat. Astron. Fys., 2(11), 1-52, 1905.

Mooers, C. N. K., C. A. Collins, and R. L. Smith, The dynamic struc-

ture of the frontal zone the coastal upwelling region of Oregon, J. Phys. Oceanogr., 6, 3-21, 1976.

Rossby, C. G., On the mutual adjustment of pressure and velocity

distribution in certain simple current systems, 2, *J. Mar. Res.* 1, 239-263, 1938.

Smith, R. L., A description of current, wind, and sea-level variations

during coastal upwelling off the Oregon coast, July-August 1972, J. Geophys. Res., 79, 435-443, 1974. Smith, R. L., C. N. K. Mocers, and D. B. Enfield, Mesoscale studies

of the physical oceanography in two coastal upwelling regions: Oregon and Peru, in *Fertility of the Sea*, vol. 2, edited by G. D. Costlow, pp. 513–535, Gordon and Breach, New York, 1971.

Verber, J. L., Inertial currents in the Great Lakes, *Proc. Conf. Great Lakes Res.*, 9, 375–379, 1966.



Gabriel T. Csanady has been a senior scientist with the Woods Hole Oceanographic institution, Woods Hole, Mass., since 1973. He was educated as a mechanical engineer (Dipl. ing., Munich) and worked 5 years in the electric power generation industry in German and Australia before embarking on graduate work on air pollution meteorology. He received his Ph.D. from the University of New South Wales in 1958. He joined the University of Waterloo, Ontario. in 1963, where he was professor of mechanical engineering and department chairman for a period, while also beginning a series of experimental and theoretical studies on the dynamics of coastal ourrents in the Great Lakes. In the late sixtles these studies were carried out in cooperation with the Great Lakes Institute. University of Toronto, and were stimulated by extended visits to the Department of Meleorology, University of Wisconsin, Madison, Increasing involvement with coastal oceanography led to the move to Woods Hole, where he worked mostly on dynamical problems of continental shelf circulation, with special emphasis on the coastal boundary isyar. He was editor of the green JGR for a 4-year term, anding in December 1979, and currently edits a book series on environmental fluid mechanics (Reidel Publishing Co.). He is a reciplent of the President's Prize, Canadian Meteorological Society (1970), the Editors Award, American Meteorological Society (1975), and the Chandler-Misener Award of the International Association for Great Lakes Research (1977). He is author of the monograph Turbulent Diffusion in the Environment (1973) and is currently working on another managraph entitled 'Circulation in the Coastal Coan.

News

The Love Canal: Beyond Science?

When in 1978, the New York State Department of Health issued the report, 'Love Canal-Public Health Time Bomb,' the serious effects of chemical waste contamination in the Love Canal area became an issue of national concern. A few 'sludies' since then have produced results in concert with those of initial reports that described 'conditions of acute health effects as being linked to hazardous wastes incorporated in landfill in the Love Canal site near Niagara Falls, New York. Now that a 'blue ribbon' panel of experts from the medical sciences has reviewed the problems of Love Canal, however, a different view has emerged. The 'Report of the Governors' Panel to Review Scientific Studies and the Development of Public Policy on Problems Resulting from Hazardous Wastes, transmitted in October of this year, identifies the following factors about the health effects at Love Canal:

- inadequate research designs for health effects studies. particularly regarding chromosome damage and informal surveys of the Love Canal residents:
- the inevitable necessity of time required for longitudinal prospective studies and complex retrospective studies that concern long-term exposures to hazardous wastes. inadequale intergovernmental coordination and cooper-
- allon in the design and implementation of health effects stud-

It is apparent that in the 2 years following release of the original New York Department of Health report, a most difficult state of alfairs developed. On one hand, there is clear evidence that contamination of the subsurface, groundwater and household basement areas of the Love Canal resilients occurred (toxic chemicals, including chlorinated hydrocarbons and dioxin, among many others). On the other hand, there were no 'short-term' health problems, according to most studies. The result was a state of understandable hysteria of the residents of Love Canal because of the danger of 'long-lerm' health problems such as the development of cancer, birth defects, and other conditions that might be produced by chromosomal damage. The real problem is that, according to the recent finding of the governor of New York's panel, the science is not well enough developed to undersland, much less to prove, a causal relationship.

The alarm raised in 1978 was, in part, a legal requirement of state law section 1388 to insure adequate jurisdiction and resources for governmental response to the Love Canal situation.' To obtain support for a 'national disaster,' the New York State Department of Health had to define the disaster. Unfortunately, the state of lear and anxiety that resulted led to an unfortunate test of the scientific method. The panel re-

This Panel recognizes that there was a reason for the State Health Department's initial announcement of 'Public Health Time Bomb,' but not a good enough reason. There ought to be a better mechanism for convincing the Federal government that a certifiable disaster area exists, in order to obtain Federal funds, than to arouse such fears of imminent peril as swept through the Love Canal area in this case. A better mechanism might have been found if effective Federal/State consultations had been launched promptly when the problem was first recognized. It may be that the atmosphere of public nearhysteria which was created in mid-1978 contributed to the failure on the part of public health agencies to pul together an appropriately orderly, deliberative and systematic investigation of the situation.

This Panel acknowledges that the Love Canal problem was something quite new, a situation not encountered before by public health agencies. In the past, inslances of environmental pollution emerged as sudden. acute episodes, usually derived from a single industrial source, with readily discernible and quantifiable health hazards. Love Canal, in contrast, represented the chronic contamination of a whole community's living space, extending back over a period of decades, and most complex of all, involving not one but scores of different chemicals seeping through the earth and into households all at once. No book of rules exists for handling this kind of problem, but from now on it is obvious that rules will have to be formulated.

The Environmental Protection Agency (EPA) released a study of the problem that the panel describes as 'a paradigm of administrative inaptitude. Although the EPA qualified its findings to be used with 'prudence' because of inadequacies study. the findings were widely distributed, nanotheless According to the panel report:

The public was given the strong impression that the Love Canal pollution was endangering the survival of all contacts and their offspring. During the next few weeks the Biogenics report (basis of the EPA findings) was reviewed by several groups of experts in the field of cytogenetics, with expressions of doubt that the reported results were of significance. These were particularly critical of the techniques employed, the tack of controls, and the possibly artifactual nature of the supernumerary acontric fragments.

With so much at stake for the residents involved, to have set up experiments that lead to public conclusions of such magnifude, without prior review of the protocol by qualified uninvolved peer scientists, and without any after-the-fact, independent review of competent scientists before release of the results, was a disservice to the citizens most intimately concerned and, as well, to the public at large.

It is a pity that this matter was so badly handled. There was no good reason why the responsible authorities in EPA could not have consulted beforehand with their counterparts in the New York State DOH, and enlisted the advice and close participation of outside consultants

with international reputations in the field of cytogenetics, and then mapped out a thorough, careful and scientifically valid approach to the question of chromosome

There is now no question that a proper cytogenetics study is urgently needed. The Panel does not know whether the degree of chromosomal injury claimed in the Blogenics Laboratory study, even if confirmed, is in itself a reason for alarmed predictions concerning cancer or congenital defects-indeed, similar chromosomal abnormalities are characteristically observed in other circumstances (measies, for example) without known sequelae. However, the mere fact that the chromosomal damage is real—if it is—means that the residents of Love Čanal are being biologically affected by something in their environment, and this observation-if confirmed—would greatly weaken the position, taken by some, that the only ill effects suffered by this population are psychological.

There will be, no doubt, countless studies of the Love Canal incident in the future. The U.S. Public Health Service, the National Academy of Science, and the New York State Department of Health will initiate studies or maintain progress in studies now underway. Perhaps science will benefit by these studies, and, possibly the forefront of environmental/health research will be extended. Right now the important questions about cause and effect, risk assessment, and acceptable levels remain unanswered.—PMB &

Postal Cancellation From Spaceport

The John F. Kennedy Space Center, in cooperation with the United States Postal Service, is offering a cancellation service to interested philatelists for the space flight programs

Philatelists who wish to avail themselves of this service may do so by following the procedures outlined below:

 Specify the event for which you wish this service. There is a limit of five covers per customer per event

 All covers must be self-addressed and bear at least firstclass postage or proper postage for international mail, placed three quarters of an inch down from the right top of the cover. Envelopes should contain a filler not to exceed the thickness of a postal or computer card to assure a clear cancellation.

 All inquiries must be accompanied by a stamped, selfaddressed envelope. Requests for service must be received at least 5 days prior to an event, but no earlier than 30 days before.

Requests should be sent to Chief, Mail and Distribution Services, SI-SRV-1M, Kennedy Space Center, FL 32899.

Services not provided are: requests for personally autographed covers, or for carrying covers on board during flight or preflight activities; cachet service (rubber stamp) for such major events as

the first launch of the space shuttle; hand-back service.

Since the Kennedy Space Center post office is open only Monday through Friday, excluding legal holidays, envelopes cannot be cancelled on Saturday or Sunday. Cancellations for minor tests cannot be given because access to these schedules is not available. 33

Radio Astronomy in Earth Studies

A high precision radio astronomy system has been adopted and used at the Goddard Space Flight Center in studies of the movement of the earth's crust. Very Long Baseline Interferometry (VLBI) can measure the rotation of the earth, and polar motion, with a current precision of better than 10 cm. Such precise measurements may shed light on the relationship between changes in the earth's orientation and movements in the earth that are associated with large earthquakes. Such movements may occur before an earthquake, but so slowly and over so large a region as to be undetectable by conventional means. Using VLBi stations, the Crustal Dynamics Project has made measurements on the longer baselines to measure continental drift, and on the shorter ones to monitor regional activity.

The lechnique uses two or more antennas to observe fixed extragalactic sources, usually quasars. Applying this principle to Earth crustal studies, the quasar signal's difference in arrival limes at the two stations can be used to geometrically determine the distance between the two stations with a high degree of accuracy.

The baseline, or straight-line distance, between stations at Westford, Massachusetts, and Bishop, California, has been measured with a precision of 3 cm, or better than one part in a hundred million.

Formation, with other countries, of a global station network and some of its work were reported by geophysicist Chopo Ma at the AGU Fall Meeting in San Francisco, December 10. Ma reported that a number of fundamental questions in geophysics are now being investigated by using space techniques. What is the nature and magnitude of tectonic plate motion? What is the behavior within a plate, especially continental plates such as North America? What is the relationship between fluctuations in the earth's rotation and large

The VLBI method is now using a highly sensitive, accurately calibrated, automated system (Mark III) which is designed for making geodetic measurements with fixed or mobile radio astronomy antennas of various sizes, ranging from 4 to 64 m in diameter. The project has conducted geodetic observations with the Mark ill systems at fixed radio astronomy stations in California and Massachusetts, mentioned earlier, and at Green Bank, West Virginia; Ft. Davis, Texas; Onsale,

Sweden; Bonn, W. Germany; and Chilbolton, England. The Crustal Dynamics Project group at the Jet Propulsion Laboratory is implementing the Mark III system into a mobile station for measurements of crustal movements in the western United States.

Since 1976, measurements from Massachusetts to West Virginia and California indicate overall continental stability, i.e., no more change than 2 cm/year. The baselines to Texas. first measured in April 1980, will allow more detailed examination of the eastern and western sections of North America. Many measurements have been made in California since that is an area of known regional activity.

In cooperation with the National Geodetic Survey and several international organizations, VLBI measurements were made by NASA in July, September, and October 1980, as part of the Monitoring Earth Rotation and Intercomparison of Techniques Program. These data, equal in amount to what was acquired in two previous years, are now being analyzed and are to be published next spring. They will provide unprecedented opportunities to compare the details of the earth's orientation as determined by other techniques and to check the United States-to-Europe baselines for plate motion and stability.—PMB 33

New Marine Studies Center

Temple University has established a Center for Marine Studies with faculty members from four of its colleges. The center will offer courses leading to a certificate in marine

Studies will focus on urbanization's impact on the marine environment and will focus on management and economics of waterfront utilization. In addition, faculty members will be constructing an artificial reef off Absecon Inlet to determine if increasing protective environments will permit increased sport fishing.

Course offerings will range from oceanography and marine biology to scuba diving and underwater research and data

For additional information about the center, contact Robert Leahy, Director, Center for Marine Studies, Temple University, 209 Beury Hall, Philadelphia, Pennsylvania 19122 (call

Weather Predictions on Target

The western third of the United States will be warmer and dryer than normal this winter, according to Jerome Namias, a meteorologist at the Scripps Institution of Oceanography's Climate Research Group. However, the East coast will be colder and wetter than normal, he predicted. These predictions, made early in December, have proven correct through the beginning of January.

'Indications point to colder than normal temperatures over the eastern half of the nation and also over the Southwest from New Mexico through Oklahoma and Texas, and warmer than normal temperatures over the western third of the nation, said Namias, a principal investigator for Scripps' North Pacific Experiment (Norpax). Florida will probably experience near-normal temperatures.

A major change from last winter's weather, the predicted pattern is the result of a trough in the prevailing winds between 3,000 and 12,200 m. Last winter's weather was mild from the Great Plains eastward to New England, dry and relatively snowless over much of the East, but abnormally wet over the Southwest, particularly in California.

This winter, the prevailing-wind trough is expected to extend from New England southwestward to Texas, where a strong ridge is expected over the Canadian Rockles and

The influence Of Man On The Hydrological **Regime With Special** Reference to Representative and **Experimental Basins**

Proceedings of the Helsinki Symposium June, 1980

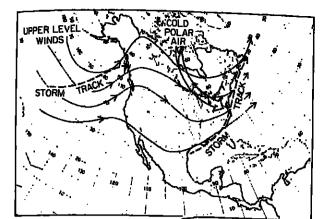
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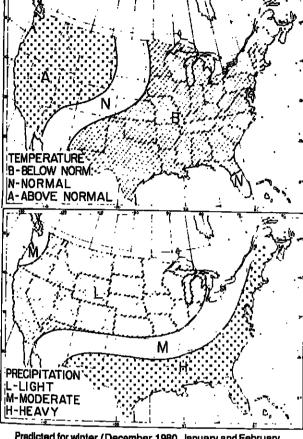
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Predicted for winter (December 1980, January and February 1981). Source: Scripps Institution of Oceanography.



Predicted for winter (December 1980, January and February 1981). Source: Scripps institution of Oceanography.

along the West coast. This wind pattern would encourage movement of cold polar air masses into the East but would shield the West, Namlas explained. This pattern also favors more frequent storms along the Gulf Coast and the Atlantic

In the East, some of the snows, once generated, would influence the atmosphere that would further refrigerate the air, he said. 'By increasing the temperature contrast between the continent and the Gulf Stream, development of East coast storms would be enhanced,' Namias adds.

The Dakotas, Nebraska, and parts of Colorado, New Mexico, and Arizona, which lie in a region between the above and near-normal temperature zones, will experience large weekly temperature fluctuations that will average out to near-normal temperatures for the season.

Namias' weather-prediction techniques utilized, in part, dala on ocean-water temperatures as indicators for changes in climate over the continents. 33

Federal Coal Directory

A new catalog that provides the addresses and the telephone numbers of more than 400 national and local coalrelated offices of the U.S. Geological Survey, Office of Surface Mining, and the Bureau of Land Management is available from the USGS.

The 41-page publication, a cooperative effort of the three Department of the Interior agencies, contains a statement of slate of selected headquarters offices and field offices.

Single copies of the new publication, 'Catalog of Selected Offices of the Office of Surface Mining, Bureau of Land Management, and the Geological Survey Relating to Coal, 1981' (USGS Circular 840), may be obtained free of charge from the USGS Branch of Distribution, 604 South Pickett Street, Arlington, Virginia 22304. 88

Atmospheric Sciences Assistantships

Research assistantships for graduate students in the atmospheric sciences are available from the National Center tor Aimospheric Research (NCAR). Research topics should cover atmospheric dynamics, climatology, cloud physics, atmospheric chemistry and radiation, upper atmosphere physics, solar and space physics, oceanography, or environmental and societal impact assessment.

Appointments are half-time and offer salaries of \$8085 for udents who have passed comprehensive examinations and \$7520 for those who have not. Maximum tenure for Ph.D. Candidates is usually two years, but M.S. candidates are usually restricted to 1 year. In unusual cases, an additional year nay be possible

Additional information may be obtained from Betty Wilson. Administrator, Advanced Study Program, NCAR, P.O. Box 3000, Boulder, Colorado 80307. 22

Geophysicists

Neil H. Berg is now in charge of snowpack research for the Forest Service's Pacific Southwest Forest and Range Experiment Station in Berkeley, California. In his new position, he will direct a team of scientists to study forest management in the snow zones of the Sierra Nevada and Coast Ranges in



George A. Paulikas has earned a Trustee's Distinguished Achievement Award for 'outstanding international leadership in magnetosphere physics and its applications to military space systems' at The Aerospace Corporation. The award consists of a bronze plaque and \$10,000 cash.

Paulikas, associate editor of the Journal of Geophysical Research, 1972-1974, has been director of Aerospace's Space Sciences Laboratory since 1968.



Atheistan Spilhaus will be a Distinguished Scholar at the Center for the American Experience, Annenberg School of Communications, and a research fellow in the Institute for Marine and Coastal Studies, University of Southern California, Los Angeles, from January through June 1981.

Herbert W. Stoughton joined the geodetic survey squadron of the Defense Mapping Agency at the F. E. Warren Air Force Base in Wyoming.

Robert L. Wesson has been officially appointed assistant director for research at the U.S. Geological Survey in Reston, Virginia. He succeeds James R. Balsley, who retired a year aco. Wesson has contributed to earthquake research aimed at prediction and mitigation of quake hazards.

Geophysical Events

This item comprises a selected portion of SEAN Bulletin, 5 (11), November 30, 1980, a publication of the Smithsonian institution.

Volcanic Activity

Mount St. Helens Volcano, Cascade Range, southern Washington, U.S.A. (46.20°N, 122.18°W). All times are local (GMT - 8 h). After the explosions of October 16-18 and the brief period of lava dome growth that followed, activity at Mount St. Helens was limited to vapor emission and occasional seismic activity through early December.

Most early November seismic events were caused by rock slides from the crater walls. No significant local earthquakes or hermonic tremor were recorded until mid-November, when brief episodes of harmonic tremor began, barely within the detection limits of sensitive seismographs on and near the volcano. Intermittent low-level tremor continued through early December. Stronger tremor started on November 25 at 2054, gradually fading into background noise about 35 min later. Observers in a U.S. Forest Service aircraft reported a slightly brighter glow in the dome area after this event. A second burst of stronger tremor began November 27 at 2034. continuing for about an hour, and several more such episodes, lasting only a few minutes each, were detected through November 30.

U.S. Geological Survey monitoring of the north crater rampart revealed a maximum net outward movement of about 23 cm between the October explosions and November 26. However, a major reversal to inward movement occurred in late October before an outward trend resumed in November. Outward growth accelerated in mid-November to slightly more than 1.5 cm/day at times, a rate similar to that recorded dur-

2.2 22 July (7) 7 Aug. (10) 🛡 - 12 June (9) 🛈 1.9 0 25 May (11) 18 May (9) ERUPTION DAY (18 May = 1) Essential Ejecta (14) = number of analyses 5.4 7 Aug. (16) 22 July (7) 5.2 **●12 June (9)**

₱ 25 May (11)

18 May (9)

Fig. 1. (a) Average MgO and (b) CaO concentration in cruptive rocks from each oruptive episode at Mount St. Hetens, May 18 to August 7, plotted against time of each episode (May 18 = 1). Analyses are of fused powders by the electron microprobe. Numbers in parentheses are the number of samples analyzed and included for average value.

ERUPTION DAY (18 May = 1)

Essential Ejecta

(14) = number of analyses

ing the summer. About 20 cm of expansion was measured between November 12 and 26.

No major changes have taken place in the volume or ratio of gasses emitted by the mountain. Two large fumaroles opened in the crater floor, very close to the margin of the lava dome, one on November 18 or 19, the other on November 25. As they opened, both ejected mud (containing no fresh magma) that coaled snow on the flank. As of early December, the new fumaroles were 2-3 m across, glowed cherry red, and puffed noisily at half-second intervals. The following is a report from W. G. Melson.

A small but definite trend toward andesite compositions is revealed by major element analyses of the 18 May to 7 August eruptives. A total of 46 samples of probable essential ejecta have been analyzed (Table 1 and Flaures 1a and 1b) a minimum of five such samples from each eruptive episode. The trend is an irregular one and is more pronounced with regard to MgO and CaO when plotted against time of eruption.

Information contacts: Tom Casadevall, Chris Newhall, and Don Swanson, U.S. Geological Survey Field Office, 301 E. McLaughlin, Vancouver, WA 98663.

Robert Tilling, U.S. Geological Survey, Stop 906, National Center, Resion, VA 22092.

Sleven Malone, Robert Crosson, and Elliot Endo, Graduate Program in Geophysics, University of Washington, Se-

William G. Melson, NHB Stop 119, Smithsonian Institute, Washington, D. C. 20560.

Paviol Voicano, Alaska Peninsula, Alaska, U.S.A. (65.42°N, 161.90°W). All times are local (GMT - 10 h). An eruption from Paviof November 11-12 ejected large lava fountains and ash clouds that reached 11 km altitude and may have produced lava flows.

A selamic station 10 km southwest of Paviof registered a 21/2 min burst of low-amplitude harmonic tremor beginning on November 5 at 1351. Emission of steam, ash, and some blocks from a vent high on the northeast flank started Novamber 8 at 1047 and lasted about 5 min, without accompanying selamicity. A second burst of low-amplitude tremor

TABLE 1. Averages for Each Eruptive Episode of Mount St. Helens, May 18 to August 7

mber	SIO ₂	Al ₂ O ₃	FeO*	MgO Ca	O K₂O	Na ₂ O	ПО₂	P ₂ O ₆	MnO	Sum
1 2	64,13 64.19	17.61 17.92	4.04 3.99	1,88 4.1 1,91 5.1		4.63 4.83	0.56 0.50	0.15 0.15	0.00 0.00	99.16 99.94
3	63.72 63.49	18.04 17.87	4.24 4.44 4.39	1,99 5. 2,20 5. 2,17 5.	16 1.25 22 1.26 30 1.23	4.97	0.64 0.57 0.64	0.15 0.15 0.16	0.00 0.00	99.89 00.17 00.57

Electron microprobe analyses of fused powders by W. Melson, T. O'Heam, and J. Nelen, Smithsonian institution. Samples collected by 1. May 18 average nine analyses; 2, May 25 average 11 analyses; 3, June 12 average nine analyses; 4, July 22 average nine analyses; 5, August 7 average 10 analyses.

1. Total fron calculated as FeO.

occurred between 0536 and 0541 on November 9.

in contrast to the pattern observed before eruptions in 1973, 1974, 1975, and 1976, virtually no additional seismic activity was recorded until a group of seven low-frequency volcanic earthquakes occurred at about 2300 on November 10. After an explosion event appeared on selsmic records at 0243 on November 11, 10 more low-frequency volcanic earthquakes were recorded between 0300 and 0400. Continuous harmonic tremor, of fairly low amplitude, began at 0608, but amplitude intensified around 0900.

Reeve Aleutian Airways pilot Everett Skinner saw rocks up to 1 m in diameter rising 10 to 30 m at 1315 on November 11. An observer in Cold Bay, 60 km to the West, noted an increase in activity about 1600. Skinner returned to the vicinity of Pavlof between 1630 and 1700, reporting lava fountaining from the summit, a black cloud hugging the volcano's upper north flank, and an eruption column reaching an estimated 6 km altitude. Between 1800 and 2000, various witnesses reported lava fountaining to a maximum height of 300 m and incandescent material moving down the north flank. A satellite image returned at 1958 shows a nearly circular plume, 15 km in diameter, north of the volcano. Activity was visible through the night from Cold Bay (see above) and the Sand Point area (50-65 km to the east northeast).

The next morning, at 0946, a satellite image revealed a plume 160 km long and almost as wide spreading north of Pavlof. Spectral analysis and weather balloon data indicate that the plume reached 8-9 km above sea level. Pilot reports on November 12 placed the top of the cruption cloud at 9 km at 1000, 6 km at 1100, and 11 km at 1400. The eruption clouds were described as varying from ash-rich to ash-poor. A helicopter craw from KENI television, Anchorage, videotaped pulses and bursts of lava fountaining, rising 150-300 m between 1600 and 1700. The fountains emerged from a preexisting vent high on the northeast flank, the only vent confirmed active during the eruption.

 Very high amplitude harmonic tremer accompanied the eruption, reaching its strongest levels between 2000 on November 11 and 0700 on November 12. Tremor ceased at 1835 on November 12, at which time many B-type earthquakes began to be recorded.

By the morning of November 13, the eruption had ended. Several hundred B-type events per day were recorded November 14-15. Renewed high-amplitude tremor began November 15 at 1306, lasting until 1711. B-type earthquakes continued November 16-19, but fewer than 100/day were re-

Information contacts: S. McNutt and J. Davies, Lamont-Doherty Geological Observatory, Palisades, NY 10964. Alison Till, U.S. Geological Survey, 1209 Orca St., Anchorage, AK 99501.

Jürgen Klenle, Geophysical Institute, University of Alaska, Fairbanks, AK 99701. G. Roberts, Cold Bay Weather Station, Cold Bay, AK

99571. Commander John Hair, Chief, Marine Environmental Branch, P.O Box 3-5000 (MEP), Juneau, AK 99802.

Gareloi Volcano, Aleutian Islands, Alaska (51.80°N, 178.80°W). All times are local (GMT - 10 h). On August 10 and 11. SO, from a fresh volcanic plume was detected from a research aircraft (flown by NASA under contract from the U.S. Department of Energy) at 19.2 km altitude just south of Anchorage, Alaska.

Imagery returned August 8 at 1010 by the NOAA 6 Satellite shows a high-altitude plume appearing to originate from the vicinity of Garelor. Using a drift rate of 30 km/hr, Los Alamos Scientific Laboratory personnel calculated that the eruption which produced this plume had probably ended about 10 h earlier. Later visual and infrared images show the plume moving loward the Anchorage area, about 2000 km from Gareloi, at a rate that could have brought it to the sampling area by August 10. The eruption column seen emerging from Gareloi August 9 by a commercial pilot was also present on satellite images, but clearly was not large enough and did not reach a high enough allitude to have been the source of the material sampled August 10-11. Wind conditions also preclude the August 7 eruption clouds from Mount St. Helens as a source for SO," in the Anchorage area at this time.

Information contacts: W. A. Sedlacek, G. H. Heiken and E. J. Mroz, Los Alamos Scientific Laboratory, Los Alamos, NM

Kralia Caldera, Myvatn Area, Iceland (65.71°N, 16.75°W). The following is a report from Karl Gronvold.

After the October eruption the magma reservoirs at Kralla inflated rapidly until the last week of November. Ground level monitoring indicates that at that time land hoight over the magma reservoirs was higher than before the October gruption. During the week or so prior to 3 December, the rate of inflation has been slower and more irregular.

From the pattern of behavior so lar, an eruption can be expected to take place soon. Evacuation plans and civil delence measures have been strengthened in case of an eruption in the southern part of the fissure system. closer to the village near take Myvain.

Information contact: Karl Gronvold, Nordic Volcanological Institute, University of Iceland, Reykjavík, Iceland.

Langila Volcano, New Britain Island, Papua New Guinea (5 53°S, 148.42°E). The following is a report from the acting Sonior volcanologist

intensified eruptive activity that began in mid-October continued until 8 November. Dark emission clouds continued to be released from crater 2, and emission clouds from crater 3 were paie gray. Ejections of incandescent lava fragments from both craters were accompanied by rumblings and explosion sounds. The lave flow from craler 3 was reported to be still active on 11 November.

A decline in the intensity of the eruption was evident on 8 November, when seismograph attenuation was reduced by 18 decibels. However, glows and ejections of incandescent lava fragments continued from both craters, and gray ash and vapor clouds continued to be

Information contact: Acting senior volcanologist, Rabaul Observatory, P.O. Box 386, Rabaul, Papua New Guinea.

Kevachi Volcano, Solomon Islands, Southwest Pacific (9.03°S, 157.93°E). Solair pilots flying over Kavachi Volcano on October 14 observed a similar submarine eruption to that reported by Chief Pilot Bruce Kirkwood on October 7. although there appeared to be more mud in the surrounding seas than during the earlier activity. By October 23, activity had decreased to occasional bursts of hot water at the sur-

Information contact: Deni Tuni, Geology Division, Ministry of Natural Resources, Honiara, Solomon Islands.

Volcanic Activity in the Philippines, September-November

Bulusan Volcano, Luzon Island (12.77°N, 124.05° E). Bulusan's most recent ash eruption, on September 28, was followed by a series of volcanic earthquakes which became less frequent with time. Felt events of intensity I to II on the Modified Rossi-Foret Scale have also occasionally been re-

Mayon Voicano, southeast Luzon Island (13.26°N, 123.62°E). Short-duration harmonic tremor was first noted at Mayon on August 16. Occasional tremor continued Through November, and as of November 30, 214 episodes had been recorded. Similar seismicity preceded the 1978 pruption and accompanied crater glow in July 1979.

Canizon Volcano, Negros Island (10.41°N, 123.13°E). Seismic activity at Canlaon has lessened considerably since it started on May 6, 1980, but remained above normal as of late November. Cantaon last erupted in mid-1978, ejecting ash intermittently

Information contact: Olimpio Peña, Acting Commissioner, Commission on Volcanology, 5th floor, Hizon Bidg., Quezon Blvd. Ext., Quezon City, Philippines.

Myofinsho Submarine Volcano, Mariana Islands, Japan (31.92°N, 139.92°E). All times are local (GMT + 9 h). The crew of the fishing boat Suitenmaru 11 saw discolored water over Myojinsho on November 15 at around 1530. They reported that no discoloration had been seen there that morning. Personnel from the Japan Maritime Safety Agency (JMSA) flew over the site on November 18 and observed three circular areas of pale green water, each 50-80 m across, aligned within a 300-m zone. These were also seen the following day by the crew of the fishing boat Shinkomaru 26 and again by JMSA personnel on November 28. No float-

ing ejecta or upwelling of water were noted, however. The November activity is the first since July 13, 1979, when JMSA observed discolored water. In 1952, 31 persons aboard the research vessel Kaiyo Maru 5 were killed by a

violent phreatic eruption of Myojinsho. Information contacts: Japan Maritime Safety Agency, 5-3

Tsukiji, Chuo-ku, Tokyo, Japan. Seismological Division, Japan Meteorological Agency, 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100, Japan.

Submarine Volcanos, Volcano Islands, North Pacific Ocean. The Japan Maritime Safety Agency (JMSA) continues frequent monitoring flights over several known submarine volcanoes (see table below). The most active of these Fukutoku-oka-no-ba (24.28° N, 141.52° E), formed islands in 1904 and 1914, and discolored sea water in 1950, 1952-1953, 1955-1956, 1958-1959, 1962, 1967-1968, and 1973-1980. Discoloration has also been seen occasionally over Fukujin (21.93° N, 143.47° E) each year since 1977. Minamihiyoshi (23.50° N, 141.90°E) discolored seawater January-March 1977 and January-March 1978, but has not been active since. An adjacent vent, Nikko (23.08° N, 142.32° E) has shown no signs of activity since July 1979. (See Table 2.) Information contacts: Same as for Myojinsho.

TABLE 2. Volcanic Activity at Three Sites in the Volcano Islands, April to October 1080

White to Actional 1990					
Date of Observation	Fukutoku-oka-no-ba	Minami-hiyoshi	Fukujin		
April 24	D	N	N		
May 12	D		Ď		
June 16	D	N	Ñ		
July 7	D	<u></u>	<u></u>		
July 8	D	N	N		
July 14	D	Ň	Ñ		
August 18	N	Ň	Ñ		
September 4	N	Ñ	Ñ		
October 21	Ň	Ñ	Ñ		

D, discolored water observed. N, no discolored water. Blank, no

Sakurazima Volcano, Kyushu, Japan (31.58°N, 130.65°E). The number of explosions recorded at Sakurazima declined from 21 in September to 4 in October, then increased to 21 in November (see Table 3). The highest October ash cloud reached 2.0 km on the first. None of the October activity caused any damage. Lapilli from the largest November tephra cloud, which rose 2.5 km on November 8, broke five car windshields. The air shock from the November 28 explosion broke two windows in a hotel at the base of the volcano. No injuries were reported.

The November 23 explosion was the 267th of 1980, making the year's total the greatest since 1974. Information contact: Seismological Division, Japan Meteorological Agency, 1-3-4 Olemachi, Chiyoda-ku, Tokyo 100, TABLE 3. Explosions From Sakurazima, October-November 1980

	Number of Explosion
October	
1	1
16	1
19	1
24	1
Total	4
November	
1	2
2	1
2 3	3
7	2
8	2
9	1
10	1
13	2
22	. 1
23	Ź
24	3
28	Ĭ
Total	21

Asama Voicano, central Honshu, Japan (36.40° N, 138.53° E). Monthly seismicity at Asama increased from 1114 recorded events in September to 1350 in October (see Figure 2), the highest monthly total since August 1977. Seismic activity decreased to 897 recorded events in November. No eruption or increase in steam emission were observed. Asama last erupted in 1973, when the number of earthquakes reached 5612 per month.

Information contacts: Same as for Sakurazima.

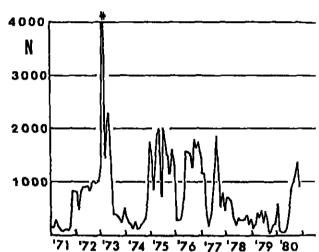


Fig. 2. Number of seismic events recorded per month at Asama. January 1971 to November 1980. The eruptions of February and March 1973 are indicated by arrows at the top of the figure.

Earthquakes

	GMI	Magnitu	ide Latitude
Nov. 8	1028	7.4 M	41.16"N
Nov. 11	1037	6.9 M	, 51,43°S
Nov. 12	0658	5.2 <i>m</i>	, 13.09°S
Nov. 23	1835	6.9 M	40.81°N
Nov. 26	1736	4.7 m	8.10°N
Longitude		Depth of Focus	Region
124.34°W		14 km	off the coast of north California
28.84°E		10 km	Atlantic-Indian Ridge south of Africa
74.45°W		shallow	south central Peru
15.34°€		6 km	south Italy
72.22°W		shallow	east Venezuela

The California earthquake caused a bridge collapse that injured six persons, but damage was generally light and no other injuries were reported. The Peru shock killed at least ijuled al ieasi 20 others, and ieil in homeless. Casualties and damage were concentrated in the San José area, 80 km east of Ayacucho. About 25,000 km of south Italy were devastated on November 23. As of early December, official casualty figures listed 3105 as killed, 1575 missing, and presumed dead, and 1671 injured. An estimated 200,000 were left homeless. The November 26 event injured 36 people and badly damaged 30 buildings in Cucuta. Colombia, on the Venezuelan border.

Information contacts: National Earthquake Information Service, U.S. Geological Survey, Stop 967, Denver Federal, Center, Box 25046, Denver, CO 80225.

United Press International The Associated Press. The New York Times.

Fireballs

Atlantic Ocean, November 15, 2300 GMT. Observer: Capt. Zweigler, F/O Graf, F/E Kogelnig of Luft hansa Flight SH 519, (Caracas - Frankfurt) Location: 22.45°N, 48.15°W, aircraft course 031° magnetic altitude 8.8 km.

First sighting: 76° magnetic, 30° above horizon. Last sighting: 91° magnetic, 10° above horizon. Durällon: 20 ş. 🤚

Apparent brightness: like full moon. Color: white at the beginning, yellow at the end. Size: about half of the full moon.

The object initially possessed a smoky tail about 4 times the length of its head. When last seen, the fireball was separating into four or five pieces. A yellow afterglow lingered for

Information contact: Gerhard Pointzky, Universitaets-Stemwarte, Tuerkenschanzstrasse 117, A-1180 Wien.

Atlantic Ocean, November 17, 0106 GMT. Observers: Capt. Heile, F/O Behrendt, F/E Schmidt of Lufthansa Flight LH 421, (Boston - Frankfurt) Location: 42.53°N, 57.20°W, aircraft course 065° true. aiti-

lude 9.4 km. First sighting: 065° true, 40° above horizon. Last sighting: 045° true, 5°-10° above horizon. Duration: 3 s.

Apparent brightness: like full moon. Color: blue-green, then yellow-red. Size: 1/4 of full moon.

information contact: same as above.

Austria, August 11, 2159 GMT.

Observer: K. Franger. Location: Gloggnitz, Austria (47.68°N, 15.97°E). First sighting: right Ascension 21 h 20 min declination

Last sighting: right Ascension 18 h 45 mln declination

The fireball was first observed in the constellation Cepheus and disappeared in Lyra. It had an initial magnitude of -2, intensifying to -8 on explosion of the bolide. At this point, the shadows of nearby trees could be clearly seen. No noise was

heard. An afterglow was visible for 10 s. information contact: same as for Atlantic Ocean.

Czechoslovakia-Poland border, October 3, 2300-2400 GMT. The following is a report from Zdeněk Ceplecha.

A fireball of -- 10 maximum absolute magnitude was photographed by at least 2 stations of the European network. The fireball traveled a 52 km luminous trajectory in 2.8 s. No visual observations are available and the time of tireball passage is rather uncertain. The following results are based on 2 photographs of the Czech part of the network.

	Beginning	Maximum Light	Terminal
locity (km/s)	18.6	17.6	16.7
ighi (km)	73	48	43
titude	49.39°N	49.61°N	49.64°N
ngitude	18.73°E	19.11°E	19.18°E
agnitude	-4	-10	-4
ass (kg)	9.8	1.3	Ġ
R	58.0°	56.0°	56.0°

Fireball type: II. Meteorite fall very improbable.

Radient (1950.0)	Observed	Geocenir	ic 	Hellocentric
Alpha	345°	341°	_	
Delta	40	-2°		-
Lambda	<u> </u>			301°
8eta	_			2°
initial velocity (km/s)	18,6	15.2		39
Orbit (1950.0)				
Α ΄		4.0	A.U.	
E		0.8	•	
Q		0.88	A.U.	
Aphelion		7.0	A.U.	
Omega		227.0°	-	
Ascending n	ode	190.45°		
Inclination		2.0°		

Meteor shower: perhaps a bright member of Capricornids. Information contact: same as Czechoslovakia-Austria.

Czechoslovakia-Austria border, November 18, 011332 GMT. The following is a report from Zdenek Ceplecha.

A fireball of -12 maximum absolute magnitude was photographed by 6 Czech stations of the European network. The fireball traveled a 53 km luminous trajectory in 0.7 seconds. A prism spectrum with dispersion of 20 nanometers (nm)/mm in the blue region was photographed from the Ondrejov Observatory. The strongest lines belong to ionized calcium (393-397 nm), jonized magneslum (448 nm) and ionized silicon (635-637 nm) and to neutral sodium (589-590 nm). Most of the medium and faint lines belong to neutral Iron, magnesium, and calcium. The following results are based on all available photographs and should be close to final values.

	Beginning	Maximum Light	Terminal
Velocity (km/s)	71.9	70.8	69.0
Height (km)	117.3	91.8	87.5
Latitude	48,821°N	48.850°N	48.855°N
Longitude	15.838°E	15.328°E	15.246°E
Magnitude	-3.8	-12.0	-4.2
Mass (kg)	0.19	0.02	none
ZR	55.8°	_	56.2°
ZR	55.8°	_	56.2°

Fireball type: III A I.

Typical cometary fireball belonging to the Leonid Meteor Shower (Parent Comet: Tempel-Tuttle). Meteorite fall impossible

The increase in brightness during the first half-second corresponds to 17 stellar magnitudes per second (6 million times per second in light intensity), which is the biggest increase of brightness we ever observed for a fireball photographed within the European network. The sudden decrease of brightness after the maximum light corresponds to 100 stellar magnitudes per second.

(1000.0)	CDSGIVGG	- COCCOTO	TOHOCOTH TO
Alpha	153.7*	153.8°	_
Delta	22.04°	21.86°	
Lambda		_	149.1°
Beta	_	_	17.7°
Initial Velocity (km/s)	71.9	70.8	41.5
Orbit (1950.0)			
A E		13 (±3) 0.92	A.U.
ā		0.9845	A.U.

	13 (±3)	A.U.
	0.92	
l	0.9845	A.U.
phelion	25 (±6)	A.U.
mega	172.7°	
scending node	235.4483°	
clination	162.2°	

Information contact: Zdeněk Ceplecha, Ondřejov Observatory, 251 65 Ondrejov, Czechoslovakla.

South Europe, November 11, 1736 GMT. Many persons in Austria and Italy observed a brilliant fireball that traveled from northeast to southwest, disappearing below the southwest horizon. Table 4 summarizes a few of the observations. None of the observers reported any sounds.

Information contacts: Maurizio Eltri and Enrico Stomeo, Via Marcantonio Bragadin No. 2, 30126 Lido, Venezia, Italy. Gerhard Poinitzky, Universitaets-Sternwarte, Tuerkenschanzstrasse 17, A-1180 Wien, Austria.

irag, October 5, 2256 GMT (October 6, 0156 local time). Observers: Capt. Schatzmann, F/O Meler, F/E Keller of Swissair Flight SR 196 (Alhens-Bombay).

Location: Iraq (33.33°N, 38.30°E), aircraft course 120° magnetic, altitude 10 km. First sighting: 125° magnetic, 10° above the horizon.

Last sighting: 130° magnetic, at the horizon. Duration: 2 s.

Brightness: dazzling. Color: blue-white.

Size: about 1/4 of the full moon. No tail was observed.

Information contact: Gerhard Poinitzky (see above).

California, U.S.A., November 12, 0350 GMT (November 11, 1950, Pacific Standard Time). Mr. and Mrs. Robert Dickey of San Juan Capistrano (33,50°N, 117.63°W) observed a brilliant fireball during an evening of moderate cloud cover. The object first appeared as a very bright flash along the meridian at a point near the ecliptic, before descending rapidty to the Southeast and disappearing near the visual horizon at about azimuth 120°. The entire event lasted between 3 and 4 s. Varying cloud thicknesses along the flight path caused brightening and darkening. Brightness was most intense during the initial flash, several times that of the full

Information contact: Robert Dickey, Bob Dickey Geotechnical, Inc., 32145 Via Carlos, P.O. Box 694, San Juan Capist-

Massachuselts, U.S.A., November 21, 1414 GMT (0914 Eastern Standard Time). David Folger saw a very bright daylight fireball from Woods Hole, Massachusetts. The object, which first appeared in the northern sky as a single blue-green ball with tall, passed through approximately 10° of arc, descending west to east at an angle of at least 30°.

In midflight, the bolide broke into two pieces, both with talls, before disappearing 30°-40° above the horizon. The complete event lasted about 1 s. No fireball sounds were heard, but they may have been masked by other loud noise near the observer.

Information contact: David Folger, Chief, Atlantic-Gulf Branch (Marine Geology), U.S. Geological Survey. Woods Hole, MÁ 02543.

West Texas, U.S.A., September 20, 0220 GMT, (Septem-

ber 19, 2120 Central Daylight Time). Observer/Location: Ed Walraven, near San Antonio, Tom Green County, west Texas (31.2°N, 100.7°W), Ronald Schorn and Michael Courtney, near College Station, Brazos County, east Texas (30.6°N, 96.3°W).

Flight path: near vertical, ending almost at the horizon. Duration: 2-3 s.

Apparent magnitude: -8 to -10.

Color: yellowish-white with red end. R. Schorn, an astronomer, believed that the velocity was sufficient to rule out man-made debris falling out of orbit and

that a meteorite fall was possible. Information contact: John West, 3502 Old Oaks Drive. Brvan, TX 77801

Observer	Location	First Sighting	Last Sighting	Ouration	Magnitud e	Color	Size	Train
	60 km northwest of Klagenfurt, Austria (47,2°N, 13.6°E)	190° magnetic, 40° above the horizon	210° magnetic	30 s	like a pyro- technical flare	white, becoming red	1/4 of moon	persisted 4 min
-	Venice, Italy (45.4°N, 12.3°E)	NE sky	SW horizon	_	~-8	white-blue	-	none persisted
Tesi Luciano	south Marcello, Italy (44.05°N, 10.78°E)	NE sky	SW horizon	_	-11 to -12	white-blue with green-red halo	_	none persisted
P. Fapperdue	Viterbo, italy (42.4°N, 12.1°E)	NNE, 50° altitude	SW horizon	10 8	-17	orange		wavy train persisted 2-3 s
-	Rome, Italy (41.9°N, 12.5°E)	-	-	-	-15	red-green with white center	_	20°-30°

*Capt. Hanisch, F/O Pillz, F/E Heptner, F/E Hoehe of Lufthanea flight LH 805 (Tel Aviv-Frankfurt).

New Publications

Applied Water Resource Systems Planning

D.C. Major and R. L. Lenton, Prentice-Hall, Englewood Cliffs, N.J., vill + 248 pp., 1979, \$19.95.

Reviewed by Richard N. Palmer

Design of Water Resource Systems, authored in 1962 by Maass, Hufschmidt, Dorfman, Thomas, Marglin, and hair (Harvard University Press, Cambridge, Massachusetts) helped to introduce a new perspective in water resource lanning. This seminal text, a product of the Harvard Water Program, combined economics and systems analysis with more conventional engineering procedures to produce new methodologies for the evaluation and design of water resource projects. Until this time few practitioners or academicians, allowing for several notable exceptions such as Arthur Morgan and Abel Wolman, had taken as careful and comprehensive a view of the process of water resource development and management. Over the years this text has had a significant influence on other water resource planners and the manner in which they approach problem solving.

In an new text entitled Applied Water Resource Systems Plenning, this influence is clearly illustrated. Together with 14 coauthors, editors David Major and Roberto Lenton present a successful application of the theory and the techniques suggested by Maass et al. in a study of river basin development in the Rio Colorado in Argentina. The study described in the book was conducted in the mid-1970's at the request of the Argentine government by a team of researchers from MIT and government officials from Argentina. The research performed three primary purposes: to adopt water resource planning techniques to Argentina, to train Argentine professionals in their use, and to apply the techniques to the Rio Colorado. The book focuses on the third of these purposes.

The twelve chapters are divided into three parts. Part 1 gives an excellent background to the problem setting, a description of the methodology used, and an overview of the remaining portions of the book, Part 2 describes four mathematical models developed to analyze the problem. Part 3 presents parameter inputs for the model, the results, the interpretations, and the perspectives. Following several of the chapters are appendices that describe in further detail topios presented in the chapters.

for the luture development and sequencing of a number of potential hydropower facilities, irrigation systems, and reservoir projects in the Rio Colorado and surrounding basins. The researchers approached their problem with two tools advocated by Maass et al.: mathematical programing and multiobjective economic evaluation. The methodology they developed to solve the problem was a series of mathematical models, differing in purpose and in complexity, that were used sequentially to evaluate potential system configurations. These models are described in chapters 5, 6; and 7. A mixed integer screening model was used to select potential development at 38 sites in the basin. Hydrologic input consisted of monthly streamflow data. Potential system configurations generated by the screening model were then tested in one of two simulation models. These simulation models differed in the degree to which the hydrologic system was described and the length of time steps used. The time steps ranged from 4 months to 1 hour increments. (Apparently, the more detailed of the two simulation models grew to such proportions that it became very expensive to use and was therefore used sparingly.) Finally, systems that appeared most favorable were investigated by using a

The problem addressed in this book was how best to plan

sequencing model that optimized investment over a 40-year time horizon. Because of the massive scale of the system, some important components were ignored. For instance, each reservoir was considered as an independent entity, and no attempt was made to derive an optimal operating policy for the system as a whole.

The book is clearly organized and well written throughout. Dospite the numerous authors, the writing is surprisingly uniform in style and is highly roadable. Terminology and notation, except where noted, seem to be totally consistent In short, there is never the feeling of a disjointed effort which is common among most books with multiple authors. Good references at the end of each chapter allow the reader to pursue topics of interest. The descriptions of the mathematical models developed in this study are exceptionally clear and concise. Of special value are the discussions that relate the various models and illustrate how the models are used to complement one another.

in addition to its numerous positive attributes, however, the book does contain flaws. These flaws are the most striking when the book is viewed as a potential lext, as is suggested in the introduction. The introductory chapters that discuss multiobjective planning and mathematical modeling (chapters 2 and 3) are superficial and do not lay the necessary foundation for the techniques that are used in the following chapters. Interested readers must seek the material that is referenced to obtain a complete appreciation of these lopics. Insufficient emphasis is placed on the process of model development and on model interpretation. The restricted number of approaches and techniques that are presented in the book prevents it from being a well rounded introductory lextbook in water resource systems. At the other extreme, the models presented in the text can no longer be considered state of the art and are not given in sufficient detail to allow the book to be used as a basic reference or as an advanced graduate text.

Despite the above criticisms, Major and Lenton's book would make an excellent supplemental text in an introductory course in water resources planning. Viewed as a case study, the book illustrates the valuable process of transforming a complex water resource problem into a system of objectives and constraints that can be quantitatively analyzed and, eventually, improve the planning process.

Richard Palmer is with the Department of Civil Engineering, Water and Air Resources Division, University of Washington, Seattle, Washington.

Marine Turbulence

J. C. J. Nihoul, Elsevier, New York, xii + 378 pp., 1980,

Reviewed by John Woods

There has long been a conspiracy among fluid dynamicists of an engineering inclination to reserve the word 'turbulence' for a very special type of nonlinear fluctuations in which three-dimensional vortex stretching drives a cascade of kinetic energy from large scale to small, often with virtually no flux divergence over some portion of the spectrum. The study of such three-dimensionally isotropic (3DI) turbulence has made a major contribution in engineering, but after 75 years of research it is clear that life is more complicated in the ocean, where mixing is normally dominated by nonlinear fluctuations that are not characterized by three-dimensional vortex stretching and are at best only two-dimensionally isotropic (2DI). Rejecting the use of the term turbulence for such important oceanic motion, one of the leading conspirators insists on using the vivid, if rather rude, term 'flatulence. This arrogant nonsense has prevailed because the engineers have until recently cornered the market in textbooks and monographs on turbulence.

At last the situation is changing. The development of new tools to measure the fluctuations in the motion and scalar concentrations in the ocean has stimulated theoretical and laboratory studies designed to improve our understanding of the phenomenon of ocean turbulence in its own right, rather than as a minor application of engineering turbulence. Monographs are beginning to emerge.

The volume under review represents a collection of 21 papers presented at the 11th International Colloquium on ocean hydrodynamics (Liège, May 1979). The Colloquium was held in association with the second IDOE-IAPSO Symposium on 'Turbulence in the Ocean.' Another book, containing commissioned review papers presented at the symposium will be published soon. The two volumes neatly complement each other: The present volume contains papers reporting results of research projects, while the latter will contain broader reviews. Both contain material covering the whole spectral range encountered in the ocean, from millimeters to megameters. Nihoul, in an introductory chapter to Marine Turbulence, identifies the features that distinguish what we find in the ocean from what the engineer finds in his/her world. The key factor is that, in the interior of the ocean (i.e., away from the boundary layers), almost all the turbulent kinetic energy occurs as motions with large Richardson number and small Rossby number. Classical 3DI turbulence occurs only at scales (~1 m) much smaller than that of structure in the mean circulation, so there is a spectral gap several decades wide between the input of turbulent kinetic energy and its entry into the 3Di turbulence that can whisk it speedily to molecular dissipation. Very little energy succeeds in leaping this gap, with the result that 3DI turbulence occurs only sporadically in short-lived bursts in otherwise laminar flow. The central problem of turbulence in the interior of the ocean is to understand the processes occurring at high Richardson number/low Rossby number.

How do the eddies, fronts, and fine structure relate to each other and to the Rossby and internal buoyancy waves propagating through them? Panchev summarizes the contribution of classical 2DI turbulence theory to this problem, following the approach of his well-known monograph. One of the themes to emerge from discussions at the Liège meeting was the need to take an integrated view in which all these motions, waves included, contribute to the overall budgets of the variances of momentum, vorticity, temperature, salinity, etc. It is therefore entirely consistent to find papers by Colin de Verdiere on Rosaby waves and Orlanski and Cerasoli on internal waves. There is no contribution in this volume on the eddies (perhaps because they will be treated extensively in a monograph now being edited by Alan Robinson), but Fedorov reports on a case study designed to illuminate the complicated phenomenon of front-line structure Interaction. That takes us up to page 100.

The remaining 278 pages are devoted to papers on the occurrence of 3DI turbulence in the ocean, mainly in the boundary layers. This is probably a fair balance in terms of effort in the research community, but not, I would have thought, if judged in terms of either the proportion of the spectrum covered by 3DI turbulence (about 0.001%) or in terms of practical applications, almost all of which lie at large

But, brushing aside these reservations, let us see what topics are included. The first theme is the cascade of kinetic energy to molecular dissipation, with contributions from Dilion and Caldwell (abstract only), Oakey and Elilott (documenting the correlation between the wind speed and dissipation in the wind mixed layer), Osborn (measurements below the wind mixed layer), and Ozmidov (ditto). There is still some uncertainty about the interpretation of the microscale measurements on which dissipation estimates are based; there are inconsistencies with measurements of scalar variarice spectra (represented here by Gregg and by Gibson). The next theme is the generation of 3DI turbulence in the interior of the ocean by shear instability (field evidence from Belyaev) and double diffusive instability (lascinating theoretical expositions by Lumley, and by Placsek and Toomre, in which we see a geophysically important phenomenon simulated on a computer by a numerical model that has no need to parameterize unresolved fluid motion). Naturally, many contributors are concerned with the turbulence in boundary layers. Revault d'Allonnes and Caulliez present a progress

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report on measurements from the Bouée Laboratoire, which can be compared with Dillon and Caldwell data already mentioned. Five papers deal with the bottom boundary layer in the presence of strong tidal currents. Bowden and Ferguson measured the vertical profile of shear stress by the eddy correlation method; and for the same area. Wolf estimated very similar shear stress values from external data and Swift used an analytical model with tidally varying turbulent kinetic energy to calculate residual currents. Then come two papers on the shear effect on dispersion in tidal flow, by Nihoul, Runfola and Roisin and by Warluzel and Benque. The final contribution, by Veth, describes a new tool—the laser-Doppler velocimeter—that may make a significant contribution to ocean turbulence observations in the future.

Conference proceedings tend to be rather patchy, and this is no exception, but Marine Turbulence contains much useful material and is recommended not only to those in the business, but also to the general oceanographer and, yes, to those who still believe in the restricted engineering definition

John Woods is director of the Regional Oceanography department, Institut für Meereskunde Kiel, Düsternbrooker Weg, Germany.

Marine Geodesy, vol. 3, nos. 1-4 N. K. Saxena (Ed.), Special Issue on Interaction of Marine Geodesy and Ocean Dynamics, Crane, Russak, New York. 436 pp., 1980, \$48.00.

Reviewed by David Wells

A symposium on the 'Interaction of Marine Geodesy and Ocean Dynamics' was held in Miami, Florida, October 10-13, 1978. The symposium was sponsored by AGU and six other organizations and consisted of four technical sessions, four concurrent workshops, and a final plenary workshop. These proceedings contain a summary of the workshops and 15 out of the 28 papers presented during the technical sessions.

The interactions between marine geodesy and ocean dynamics considered in these proceedings separate into the horizontal (a one-way interaction, the provision of precise positioning by marine geodesists to ocean dynamicists), and the vertical (two-way interactions in several common-interest aspects of sea surface height). The interactions are most intimate in the analysis of salellite-borne radar altimetry, which senses the instantaneous sea level, as affected by both the marine geodesists' 'signal' (the marine geold) and by the ocean dynamicists' signals (variously due to tides, currents, storm surges, wind, and atmospheric disturbances). This intimate interaction, in which for each the signal of the other is often noise, is well represented in the conlent of these pro-

The horizontal interaction is considered in two papers. Halslip reported on the status of radio navigation systems maintained by the U.S. Coast Guard. Seeber presented resuits from two Transit Satellite Doppler studies, on the effect of drilling rig metal decks on height determination, and on the teasibility of precisely tracking moored buoy movements.

The vertical interaction is represented by three groups of papers concerned with ocean circulation, global ocean tides, and the marine geold.

Gatto used remote sensing techniques to determine circulation patterns. Papers by Chew and by Molinari discuss currents in the Florida Straits and in the Caribbean Sea and in Gulf of Mexico, respectively, each touching (inconclusively) on the controversial interaction between steric and geodetic

Global ocean tide (GOT) models are of practical interest in the analysis, for example, of satellite altimetry data, satellite orbit perturbations, and seabed gravimetry. Zetler traced the complementary developments of GOT models and of pelagic (ocean bottom) tide gauges, data from which are invaluable. for testing and tuning GOT models. Three approaches to GOT models were described by Schwiderski (in two papers Parke, and Estes. In the first two cases, a theoretical model was used to interpolate between tidal data from coastal and Island stations. The M_2 constituent obtained by Schwiderski. agreed with the Miconstituent from Independent pelegic data to within 2 cm in amplitude and 6° in phase. Parke presented maps of some geophysically useful parameters de-

rived from modeled M_2 , S_2 , and K_1 constituents. Estes presented a purely theoretical GOT model (independent of island or pelagic tidal data) and used it in a simulation of the affect of unmodeled systematic orbit errors on the problem of extracting ocean tide information from satellite altimetry.

Determination of the marine goold from satellite altimetry is discussed in four papers. Marsh showed that in the short term (treating sea surface heights owing to dynamic effects as noise) altimetry is useful in reducing geoid uncertainties. Brace compared altimetric geoid heights with heights from several geopotential coefficient sets and altimetrically derived mean gravity anomalies with those from marine gravimetry. Torge presented a gravimetric geold for the North Sea and compared it to one derived from altimetry. For the longer term, an integrated approach to extracting both goold and dynamic signals from altimetry is needed. Parra used results from the western North Atlantic to show that gravimetric

geolds can be corrected in local areas free of permanent geostrophic features and that the study of temporal variations n quasi-steady dynamic features is the most useful contribution of altimetry to ocean dynamics.

GEOS-3 altimetry was used for all the altimetric studies reported here. McArthur described the more advanced SEA-SAT-1 altimeter, together with proposed future improvements. Ironically, the failure of SEASAT-1 was announced during this symposium.

An introductory paper by the conference cochairmen and session chairmen summarizes the workshops, which dealt almost exclusively with the altimetric connection between marine geodesy and ocean dynamics. This is an excellent tutorial paper on the present and potential uses of this new tool, full of ferment and excitement and occasionally contradictory. (One workshop concluded that mesoscale eddles can be studied with existing altimetry; another workshop con-

cluded that altimeter performance must first be improved considerably.)

Appearing in a refereed journal, these proceedings are certainly more accessible, and perhaps more carefully considered in content, than if they had been produced in a less formal way. The full flavor of the symposium is elusive, however, since nearly half of the papers presented are neither printed nor even listed by title in these proceedings. In particular, more could have been included on sea level variations from ocean dynamics effects other than tides. Nevertheless, the papers here represent a valuable and much needed contribution to our understanding of the interactions between marine geodesy and ocean dynamics and to the dialogue between marine geodesists and ocean dynamicists.

David Wells is with the Department of Surveying Engineering, University of New Brunswick, Fredericton, Canada.

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Meteorologists and Hydrologists/Saudi Arabia. The School of Renewable Natural Resources, University of Arizona, invitos applicants for issignment : · faculty membors to the institute of Meteorology and Arid Land Studies, King Abdulazia University, Jeddah, Saudi Arabia. One year, renow able positions in meteorology and hydrology are 1. Ph.D. in nieteorology with experience in under-

graduate teaching and research. Curriculum includes coursos in meteorological instruments and methods of observation, dynamic molecrology, synoptic meleorology, physical meteorology, and cit-

2. M.S. in meteorology with practical experience n meteorologic operations and undergraduate

teaching. Knowledge of WMO procedures.

3. Ph.D. in a hydrologic science or engineerin with experience in undergraduale teaching and in research Major emphasis will be in the areas of surface and groundwater development, water management in an arid environment and in evaluating the hydrologic effects of devolopmen

scription: The project is funded by the Saudi Arabian government through the U.S.-Saudi Arabian Joint Commission on Economic Cooperation Administration and logistic support is provided by the U.S. Treasury Department, while the program's imple mentation is by a contract with the Consortium for international Development. The goal of the project is to undertake technical cooperation to develop edu calional programs for meleorology, hydrology, and and studies and environmental protection

Salaries and allowances. Highly competitive with 25% overseas adjustment, housing, car and other at-

Availability: February 1, 1981, or soon thereafter for spring semester: September 20, 1981, for fall se nt of one year or more con-

tingent on performance sing date. January 15, 1981 for spring somester; February 15 for fall seme ster Application. The application should include the foling. (a) a letter detailing principal qualifications

and interests. (b) a curriculum vita (c) name, address and telephone numbers of three references. Send to Martin M. Fogel, Director, CID/King Abdulaziz University Project, 317A Anthropology Building. University of Arizona, Tucson, AZ 85721, Telephone (602) 626-5344/2989.

University of New Orleans/Geophysicist. Applications are invited for a permanent fac-ulty position commencing August 1981, in exploraon geophysics. The Ph.D. or equivalent experience

Appointee will be expected to teach graduate and undergraduate courses in geophysics and general geology, conduct a program of research, supervise theses and oversee a program in geophysics. The position will be at the assistant professor level or higher depending on background. Applications are encouraged from individuals with industrial experience, including recent retirees.

ants should send a letter outlining interest in position, complete resume, and three letters of rec-ommendation to Dr. Gordon Frey, Department of Earth Sciences, Lake Front, University of New Orleans, New Orleans, LA 70122.

Ocean Dynamicist. An academic position

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presently available in the Department of (NAVPGSCOL). Present or utilmate research interest in area of naval oceanographic concern is irable. Such areas include: ocean circulatio modeling, especially prognostication on the oceanic synoptic scale; surface and internal gravity wave ynamica; synoptic analysis of oceanic date; and acoustical oceanography. The candidate should be willing and able to leach a variety of grad courses in physical oceanography and related topics. The NAVPGSCOL has excellent compu data archival, library, and research vessel facilities.
The Department of Oceanography has close relations with the Fleet Numerical Oceanography Center, Naval Environmental Prediction Facility, and faculty of filteen and a student body of 80 to 100. The overall emphasis is ocean prediction with present pulty and aludent research in coastal ocean, pole ocean, and air-see interaction processes. The close colleboration with the Departments of logy and Physics. Salary will be determined ions of the successful candidata. Av January 1 il possible, send a curtoulum vilae, the names and addresses of three references, and a statement of research and instructional interests to: Faculty Search Corrimities, Department of Oceanography, Navail Postgraduate School, Monterey, CA 93840. Visits by top candidates will be scheduled soon after. A decision will be attempted by March 1 and the position should be occupied by The Naval Posigraduale School is an equal

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become a tenure-track position on August 1, 1982). Minimum qualifications are a Ph O in the geological sciences, a flair for teaching, and strong research interests as proved in publications Areas of specialization (one or more of the ntation available at the department mass spectrometers for 13C/12C and 18O/16O mass spectrometers for rare gas analysis (40K)

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Charmon, Search Committee Department of Geology University of Miam P O Box 249176 iversity of Miami Branch Coral Gables, Florida 33124

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modern computing facilities, research taboratories, and two deep-ocean research vessets, the R/V Fred Moore and the R/V Ida Green. Research at Galveston includes programs in marine geophysics, marine geology, solid earth geophysics, earthquake and ex-tra-terrestrial seismology, and instrument systems

design, both basic and applied.

Applicants are asked to send the following: (1) Vita—including fist of publications. (2) Brief statement on current research and

(3) Brief statement on administrative experi-

(4) Brief statement on teaching experience. (5) Names of six persons who may be con-tected for personal and professional rec

A letter of application and the above requested inormation should be sent to:

Or. J. Robert Moore, Director Marine Science Institute versity of Texas

P.O. Box 7999, University Station Salary based on qualifications. Ph.D. required. The successful candidate will also be considered for enure appointment in the Department of Marine

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Sedimentary or Low Temperature Geomist. This is an assistant professor, tenure track position, although exceptional cand higher rank will be considered. We are looking for a geochemial to complement our atrong programs in aedimentology, hydrogeology, organic geochemistry, and basin analysis. The teaching load is three courses per year—one beginning level geglogy course, an upper level geochemistry course. graduate course of his/her choosing. Infroductory geology and summer field camp are elso laught on a long-term rolating basis. A well-equipped laboratory and computer facilities are available. The potential exists both for outside funding and for coop

The successful candidate will be expected to conduct an active research program leading to pub-lications. Applicants should submit a letter of application, resume, a copy of each transcript, and have

three supporting letters sent to: Chairman Department of Geology University of Missouri Columbia, Missouri 66211

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Resource/General Geologist. The University of Patisburgh at Bradford will have a tenure track opening for a resource or general geologist in Sep-tember, 1981. This new position will serve an established two-year program in petroleum technology and a new, geology-based, four-year program in onvironmental sciences. Rank and salary pro necotrable. The candidate will be expected to teach of freductory or photograph interpretation and atleast ronmontal sciences program; siructural geology. strangraphy, economic geology, coal geology, in ed-dition, the candidate will teach courses in the petro form technology program that ero compatible with his or her shifts. A Ph. D. and some experience are preferred, but applicants with other qualifications will be considered. Preference will be given to those with

petroloum industry experience.

Bradford is localed in the Alegheny Mountains in an area rich in natural and recreational resources. ase send resume and three letters of reference to Carl Burgchardt, University of Pittsburgh at Bradford.

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Exploration Geophysics/University of Okla-homs. As partot a 5 year plan of development and expansion, the School of Geology and Geophys-ics is looking for a person to form the nucleus of an ploration geophysics group APh D in geophysics is required, and preference will be given to some whose teaching and research interests are in the acquisition, processing, and/or interpretation of seismic data. Present equipment includes a truck-mounted humper energy source, capable of penetrating a Prometer or more physical a contable, 12-change stism & recording system, gravingtars, magnetomi ters, an electrical resistivity and, m-house min computers, and terminals to the University's IBM 37G system. A geophysical observatory supports re-search in solid earth geophysical and the exploration grouphy sicist would work closely with the tectorics.

Schitearth geophysics group

Applications are due February 15, 1981, Salary is competitive with industrial standards. Inquiries and archallons should be sent to John Wickham Director. School of Geology and Geophysics, University of Oklahoma, Norman, OK 73019

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Qualifications Ph D. in meleorology. Research experience in advanced analysis and diagnostic studes of global-scale meteorological processes is essential, preferably over the full height of the atmosphere (0-100 km) Preference will be given to applicants who can utilize their experise in synopticity-name meteorology to synthesize the results of various ongoing research projects in mesoscale and large-scale meteorology, cloud physics, radiation, aeronomy, and space physics into a better understanding of the large-scale melecrology of the North Pacific and polar regions. Teaching experience at

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Applications For further information, including recent annual research report, write to Director, Geo-physical Institute, University of Aleska, Fairbanks, AK 99701 Closing data for applications is February

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Sedimentary Potrologist. The Geology Depariment at the University of Vermont is seeking a sedimentary petrologist for a tenure track position at the assistant professor levet. Research and teaching specializations should be in classic sedimentary pairelogy with potential anciliary interests in petroleum geology, geomorphology, and hydrology, it is ex-pected that the successful candidate will establish a ligid-oriented research program which includes supervision of graduate (M.S.) and undergraduate stulonis. A Ph D. is required and teaching experience highly desirable. The Geology Department at the University of Vermont is a seven member depart mont having an M.S. program and a definite com Applications will be accepted until April 1, 1981.

three lettors of reference to be sent to John C. Drake Acting Chairman Department of Geology University of Vermont

Burlington, Vermont 05405
The University of Vermont is an equal opportunity.

Faculty Position. The Department of Geology of the University of New Mexico seeks applicants to a position in cisy mine raiogy, low-temperature geo-chemistry, carbonate petrology, or economic geol-ogy. The appointment may be at the assistant, associale or full professor level contingent on approval of funding from the university. The individual must be strongly committed to leaching at both the under-graduate and graduate levals. In addition, he or she will be expected to develop a vigorous rese gram in his or her field of specialty and will be expocted to supervise graduate students at the M.S. and Ph.D. levels. The closing date for application is April 15, 1981. Applicants should send a résumé, un-dergraduate and graduate transcripts, three latters of toference, and a brief discussion of research interests to Rodney C. Ewing, Chairman, Department of Goology, University of New Mexico, 87131.

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Geophysics Research Associats. Weston Observatory of Boston College seeks MS in geo-physics (doctorate work desirable), familiarity with time and frequency domain analytical techniques and knowledge of FORT RAN programming. Opporlunity for independent research along with assigned responsibilities relating to New England seismic net-work. Salary to \$20,000 depending on qualifications and excellent benefits. Send letter and resume to

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Drexet University/Atmospheric Scientist.
Three tenure track faculty positions are enticipated starting fall 1961 Applications are solicited from Ph.D.s with independent research experience in one of the following areas of atmospheric science: general circulation; climate dynamics with application in satellite meteorology; atmospheric optics, experi-mental or theoretical with emphasis in mesoscal probing; boundary layer turbulence modeling and atstry modeling. Hank and salary commensurate with experience. Send resume and references to Dr. William W. Erdson, Head, Department of Physics and Almospheric Science, Draxel -University, Philadelphia, PA 19104. An equal opportunity/affirmative action employer.

Program Manager/Mateorology. Oceano-graphic Services, Inc., is seeking qualified ap-plicants for the position of program manager for maleorological studies. Applicants should have an M.S. or Ph.D. in meteorology or atmospheric sciences, plus experience in the field. A broad general knowledge of air pollution, and an un-derstanding of the air pollution regulatory environ-ment, is helpful. Interested persons should send resume, references, and salary history to R. C. Banks, Oceanographic Services, Inc., 25 Castilian Drive.

Research Plasma Physicist. Berkeley Scholars, Inc. has opening in D.C. area. Must be eligible for Ph.D. in plasma physics with specialization in and stracts presented on theory and numerical simulation of magnetic shear effects on instability phenomena as applied to ionospheric and magnetospheric problems 1 yr. work experience in the field is required Salary is \$20,000 per yr., 40 hrs. per wk. Send resume directly to Berkeley Sci P.O. Box 983, Berkeley, CA 94701. keley Scholars, inc.,

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Queens College is an affirmative action/equal op-

Geophysicist/University of South Caroline. The University of South Carolina anticipates a new faculty appointment in geophysics for 1981, subject to adequate legislative funding. We are especially interested in individuals who have expertise in cially interested in individuals who have expertise in the fields of exploration geophysics, selamic interpretation, or solid earth geophysics. This would be a 9-month, tenure track position at the assistant or associate professor level, beginning August 1981. Some start-up funds are available for major equipment purchases. The individual who fills this position would join the growing geophysical component of the Geology Department, which currently amphasizes selamology, regional tectonics, and paleomagnetics, and would develop an aggressive research program in his or her speciativ.

in his or her specialty.

Please send vitae and names and phone numbers of three individuals we may contact for references to Willard S. Moore, Chairman, Search Committee for

Geophysics, University of South Carolina, Columbia SC 29208. Closing date for this announcement is March 15, 1981

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Scientists/Meteorologists/Engineers. Science Systems and Applications, Inc., (SSAI) has positions for programmers, analysts, scientist and engineers to engage in scientific modeling and data analysis activities in the areas of: 1. Plasms/lonospheric physics theoretical simulations 2. Atmospheric/oceanic sciences 3. Remote sensing & radiative transfer/scattering studies 4. Satellite data analysis 5. Weather/climate & severe storms studies 6. Atmospheric/fluid dynamics 7. Solar and planelary physics and astronomy 8. Computer imag processing and systems displays 9. System software/hardware engineering 10. Nuclear fusion/fis-sion and 11. Applied mathematics. These positions involve working with NASA/NOAA/NAVY solentiel n metropolitan, Washington, D.C. area. A strong background in numerical simulations, and experience in working with large scale computers is required for entry level to senior scientist/engineer positions. SSAI provides a congenial academic envi ronment, pays liberal fringe benefits and awards bonuses to its employees. Please send your resum with salary history and references to Science Sys-tems and Applications Inc., The Aerospace Building, Suite 140, 10210 Greenbalt Road, Seabrook, MD

AGU

Stephen J. Burges—New WRR Editor

The 'tower of Babel syndrome' is the most important problem lacing water-resources researchers, says Stephen J. Burges, the new coeditor for hydrology and physical, chemkal, and biological sciences for Water Resources Research (WAR). Burges was appointed to a 4-year term which began November 1. He succeeds R. Allan Freeze.

Specialized research that lacks a sense of connection to other aspects of hydrology characterizes the syndrome. Burges explained. He traces this scallering of interests back. to 1966 with the 'evolution' of the third-generation computer.

To help add coherence to WRR is coverage of hydrology, Burges plans some changes. With the addition of lour associate adviors, the breadth of topics will be increased to include ecological modeling, sediments, and precipitation. In additice. Durges will ask authors to explain in a paragraph at the beginning of their papers how the research relates to other water-resources problems. Authors also will be requested to identify the status of research described in the paper, and to state clearly whose work or computer models the research

Burges said that he and coeditor Jared Cohon hope to achievo a better balance of topics and to increase readership with these changes

Under Burges, the associate editors will continue to play a major role in choosing reviewers and in maintaining the high standards of WRR; the basic management style used by Freeze has been found to be effective. In addition, Burges plans to continue to solicit appropriate review articles to add balance to WRR. Freeze initiated solicitation of these articles; Burges and Cohon plan to coordinate their selection of review lopics to bring the two major divisions of WRR closer

Following completion of his Ph.D. In civil engineering at Stanford, Burges joined the University of Washington faculty in 1970. His undergraduate degrees (physics, mathematics, and civil engineering) were taken at the University of Newcasile, Australia. His research and teaching have focused on the application of systematic approaches to analysis and design of water-resources systems, with an emphasis on ato-

'Al heart I'm a civil engineer,' Burges said. I also like using a systematic approach to problem solving. Surface water-



storage reservoirs dominate his interests. He said that he also intrigued by urban water problems, including large-s systems and flood/drought research. He views stochastic drology as an essential tool for the future. 'We need a met to determine reliability of water systems."

Burges said he looks forward to working closely with hon and maintaining the high standards set by previous eq tors. Burges noted that they are indebted to Freeze for his outstanding editorial leadership and want to thank him pub

Meetings

Recent Earthquakes Symposium

A call for papers for the symposium 'Reports of Recent Earthquakes' has been made by Ziro Suzuki, second vice president of IASPEI. The symposium will be held July 22, as a part of IASPEl's 21st General Assembly, at the University of Western Ontario in London, Ontario.

Abstract forms are available from Suzuki at the Geophyal-

cal Institute, Tohoku University, Sendai 980, Japan. Requests for the forms should include author name and address, tentative paper title, and name, place, and time of the earthquake to be reported. Completed abstract forms should be mailed by March 1 to A. E. Beck, Department of Geophysics, University of Western Ontario, London, Ontario N6A 5B7, Canada. A copy should be sent to Suzuki. Some deadline flexibility will be allowed, but authors should receive permission from the committee. Papers on earthquakes that occurred during the second half of 1980 can be accepted after

Time restricts the number of papers on each earthquake to two. Review papers rather than personal studies are pre-

European Geophysical Meeting

A call for papers has been issued for the Eighth Annual European Geophysical Society Meeting, scheduled for Auoust 24-29 in Uppsala, Sweden. Abstracts-one original and two copies-should be sent to K. M. Storetvedt, Chairman Program Committee, Institute of Geophysics, University of Bergen, Allegt. 70, N-5014 Bergen University, Norway. Deadline for receipt of abstracts is June 1.

In addition to 13 symposia, one workshop, and an excursion to a meteor-impact structure, there will be two society lectures. H. Alfvén of Stockholm will speak on plasmas in the cosmos and the laboratory, and H. Moritz of Graz will give a lecture entitled 'The Figure of the Earth.'

Applications for travel awards for young scientists are due March 31. Forms can be obtained from the EGS General Secretary, 6 Carlton House Terrace, London SW1Y 5AG.

More information about the meeting, which will run simultaneously with the Uppsala Caledonide Symposium, can be provided by the Local Organizing Committee, C.-E. Lund. Chairman, Box 556, S-75122, Uppsala, Sweden. S

Hydrometeorology Session

The 15th Annual Congress and Annual Meeting of the Canadian Meteorological and Oceanographic Society (CMOS) will be held at the University of Saskatchewan, Saskatoon, Saskatchewan, on May 27-29. The focus of the Congress will be hydrometeorology; scheduled are sessions on waves and tides, drought management, the Canadian Climate Program, environmental assessment, stratospheric dynamics, remote sensing, and polluted precipitation. In addition, sessions on air-pollution meteorology, sponsored by a CMOS special interest group, will be conducted concurrently.

Authors wishing to present papers at the congress or at the special air-pollution sessions should submit abstracts of fewer than 300 words by February 1. Address all correspondence to Barry Goodison, Hydrometeorology Division, Atmospheric Environment Service, 4905 Dufferin Street, Downsriew, Ontario M3H 5T4 (call 416-667-4914). Authors should indicate in which session they wish to be included. \$3

California Mining Association

California's minerals industry and its impact on the nation will be the focus of the 1981 California Mining Association Annual Meeling in San Diego, March 5 -7.

Technical aspects of California mining and political probems which concern the industry will be emphasized. More than 200 representatives from major industrial mining firms in the state are expected to attend.

Registration is \$75 per person; spouse registration is free. For additional Information contact the association at P.O. Box 3, Jackson, California 95642, or call (209) 223-1129. 85

Geodetic Networks and Computations

An international symposium on geodetic networks and computations will be held in Munich, August 31 to September 5. The symposium, sponsored by the International Association of Geodesy, will take place at the Bavarian Academy of

Topics to be covered at the symposium include objectives of geodetic networks, status reports, and future plans; optihal design of geodetic networks; network analysis models; space techniques for terrestrial networks; combination of horizontal, vertical, and gravity networks; and computational Problems in classical and nonclassical adjustment models. For additional information and registration forms, write to Jeutsche Geodätische Kommission, Bayerischen Akademie

er Wissenschaften, Marstallplatz 8, D-8000 Munchen 22. 38

Show Chemistry: Cali for Papers

A call for papers has been Issued for the 38th Eastern Show Conference, scheduled for June 4-5 in Syracuse, New York, A special session will be held on snowpack and snow-

Authors wishing to present a paper should submit an ab-Mract before February 15 to Barry E. Goodlson, Program Chairman, Hydrometeorology Division, Atmospheric Envitonment Service, 4905 Dufferin Street, Downsview, Ontario M3H 5T4, Canada (call 416-667-4914). 88

IASPEI Workshop: Seismic Modeling of Laterally Varying Structures

During the past 10 years, significant progress has been made in the methods of collection and analysis of seismic reflection and refraction data. This progress has led to the development of new models for the structure and composition of the earth's crust, based on sophisticated analysis of numerous profiles in many areas of geologic importance. The third triannual meeting of the IASPEI (international Association of Seismology and Physics of the Earth's Interior) Commission of Controlled Source Seismology was convened in Park City, Utah, on August 11-17, 1980, to bring together seismologists and geologists to explore and assess the progress of controlled source techniques (controlled sources include explosions, air guns, and Vibrosels-type sources), and to evaluate its significance in terms of current models of the seismic velocity structure and composition of the crust and upper mantle. Particular attention was paid to the progress and problems in the modeling of two- and three-dimensional structures.

The Park City location of the conference was ideal for the contemplation of the complex structures that we are presently attempting to model. The effects on the crust of the action of tectonic forces were easily discernible from the air during the approach to the Salt Lake City airport, and on the ground during the field trip into the Wasatch Mountains led by R. B. Smith of the University of Utah.

Two and one half days of the 5-day conference were used to discuss different interpretations of the seismic refraction data collected in Saudi Arabia by the U.S. Geological Survey In 1978 [Blank et al., 1979; Lamson and Leone, 1979]. The format of this portion of the meeting was unlike most other scientific workshops. The complete refraction data set had been distributed to the participants well in advance of the meeting, giving each seismologist (or team of seismologists) time to thoughtfully analyze the same data. The use of a common data base allowed for a kind of in-depth examination of issues of interpretation that is not possible in traditional workshops which are based on diverse data sets.

A discussion of the geologic framework of Saudi Arabia and the southeastern Red Sea was particularly pertinent because all proper seismic interpretations are constrained by the known surface geology. (The geologic map of Saudi Arabia was distributed to all participants along with the selsmic data set.) The discussions began with an introduction to the geologic problems of Saudi Arabia by H. R. Blank and an outline of the planning and goals of the 900-km-long refraction profile (see the figure, part A) by M. Q. Assad. This was followed by a series of speakers who explained their team's interpretation of the data and the methods that they used to derive velocity-depth structures. In the course of these presentations it became evident that the main source of differences in the final models is the phase correlation of the data. The term 'phase correlation' refers to the process of identifying, within a seismic record section, those arrivals which refract or reflect from the same feature (or portion) of the crustal or mantle velocity structure. For example, the phase P* refracts in the middle crust, while PmP reflects from the M discontinuity. A knowledge of the expected amplitude and frequency of a particular phase, based on experience and theoretical considerations, facilitates its correlation in the record section, but the complexity of the typically observed wave field leads to a degree of subjectivity in the interpretation of the phases. Given identical phase correlations, different methods of travel time and amplitude analysis of these phases will produce nearly the same result. Conversely, different correlations will result in markedly divergent models. These points can be appreciated from the comparison of the models of the Arabian shield (see figure, part

B) to those of the Red Sea-continent transition (see figure, part C). For the most part, the teams of interpreters agreed on the phase correlation of the profiles between shot points 1 and 5 (see figure), and the resultant models reflect this agreement. However, the correlations and interpretations of the data crossing the Red See-continent transition were diverse, which ultimately led to quite different models for that region (see figure, part C).

A few highlights of the meeting on the interpretation of the Saudi Arabian refraction data are summarized below. These lew impressions do not completely characterize the great amount of interpretive skill brought to bear on the data and the lively and constructive discussion that ensued.

(1) The upper crust (21 km thick) of the shield has a nearsurface velocity of 6.1 km/s and, in most regions, a positive velocity gradient of 0.01-0.02 km/s/km. Low velocity zones may be present in some regions.

(2) The lower crust (19 km thick) of the shield is separated from the upper crust by a selsmic discontinuity or smooth transition of 0.2-0.4 km/s. The average velocity of the lower crust is about 6.7 km/s.

(3) The M discontinuity is probably a transition zone 2-5 km thick and occurs at a nearly constant depth of about 40 km. Uppermost mantle velocity is 8.0-8.1 km/s, and there is evidence for fine structure within the lithosphere.

(4) The structure of the Red Sea-continent transition remains uncertain with the currently available data. The range of proposed models is indicated in the figure, part C. Improved models would result from the recommendations be-

A general consensus was reached on recommendations for future seismic refraction and reflection work in areas with strong lateral velocity heterogeneous structure, such as the Red Sea-continent transition in western Saudi Arabla:

- (1) Parallel-to-structure refraction profiles are needed in regions of complex structure. In the present case, refraction profiles are needed along the coastal plain and in the Red
- (2) Perpendicular-to-structure profiles must be densely recorded and should include considerable data redundancy.
- (3) Critically placed seismic reflection profiles would help resolve details in the areas of greatest structural complexity. In the present case, reflection profiles crossing the Hijaz Azir Escarpment (see figure, part A) would help in understanding the structure across this rift boundary.

The commission officers were (chairman) S. Mueller, ETH-Zurich, Switzerland, and (secretary) J. Ansorge, ETH-Zurich. Switzerland. The local organizers were D. P. Hill, Menlo Park, California; J. A. Orcutt, La Jolla, California; and R. B. Smith, Salt Lake City, Utah.

Acknowledgments

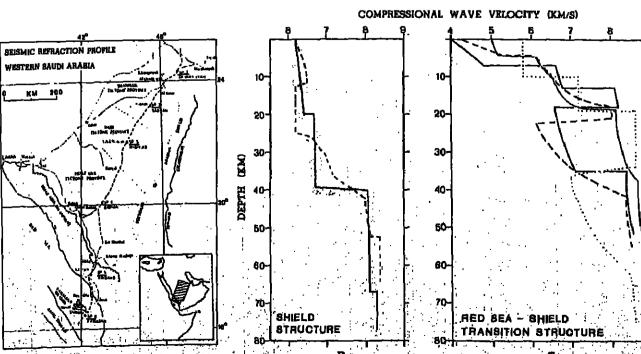
Financial support for the workshop was provided by the Office of Naval Research and the U.S. Geological Survey. We thank the Directorate General of Mineral Resources, Saudi Arabia, for persion to use the seismic refraction data for this workshop.

References

Blank, H. R., J. H. Healy, J. Roller, R. Lamson, F. Fisher, R. McCleam, and S. Allen, Seismic refraction profile, Kingdom of Saudi Arabla: Field operations, instrumentation, and initial results, Rep. 259, 49 pp., Saudi Arabian Mission Proj., U.S. Geol. Surv., Lamson, R., and L. Leone, Saudi Arabia seismic refraction profile:

Data set, Volume I and II, Geol. Surv. Open File Rep. (U.S.)

This meeting report was prepared by Walter D. Mooney,



(A) Location map, USGS-conducted seismic refraction investigation of western Saudi Arabia and the southeastern Red Sea: shot points (SP), profile line (dashed line), and tectonic provinces. (B) P wave velocity structure of the Arabian Shield, presented by workshop participants; shaded region outlines the range of velocities of most models; solid line is a typical example, while dashed line is an alternative model. (C) Four P wave velocity structures for the Red Sea-Shield transition: the data were sparse in this laterally inelregion, making possible these radically different interpretations.

AGU Spring Meeting May 25-29

Call for Papers

Abstracts must be received at the AGU office by 5 P.M. on March 4 to be on time. Late abstracts (1) may be summarily rejected by program chairman, (2) may not be published in advance of the meeting, and (3) if accepted, will be charged a \$25 late fee in addition to the regular publication charge.

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A publication charge of \$40.00 for each contributed abstract will be involced (\$20.00 if the first author is a student member and if the appropriate notation is made on the abstract when submitted.) Both invited and contributed papers are subject to the publication charge unless specifically waived in writing. To repeat, the abstract must be received at AGU by March 4 to avoid an additional \$25.00 charge. If a revised version of an abstract must be published, it will also be assessed a \$25.00 charge. Authors will be notified by mail in late April of the status of

their papers. Receipt of all papers will be acknowledged. Ten minutes is normally allowed for the presentation of each contributed paper, and only 2" × 2" (35-mm) slide projectors and viewgraphs are usually available as standard equipment at the meeting. All other equipment is available at cost plus a \$10.00 billing charge if we have to involce.

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Electromagnetics

GAP

0160 Plaguag UN TRE PARAMETRIC DEPENDENCES OF THE BEAM-PLASMA -DISCHARGE AT LOW PRESSURES AND MAGNETIC FIELD

STRENGINS
5. CuparanceOAA/ERL/SEL/ Boulder, Colorado 80303
15. Aund Bepartment of Physics and Ascronomy, Tel-Aviv University, Ramet-Aviv, Laraci) I. Roth(Department of Physics and Astronomy, Tel-Aviv University Langely Langely

rent of Physics and Astronomy, Tel-Aviv University, Ranat-Aviv, Israel)
An explanation for the relationship between the critical current and the physical parameters observed in recent experiments on beam-plasma-discharge at low pressures and magnetic fields is proposed. The observed relationship is reproduced by combining the threshold condition for clerrostatic instability in a magnetized, bounded beam-plasma system and the bulence equation for the rate of plasma production and that of less through the order. It is found that the principal scaling of the threshold criterion with variations in the magnetic field is determined by the variations in the radius of the beam-plasma system. beam-plasma system. Geophys. Res. Lett., Paper 80L1572

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Loses AND IEUS FOR OPTICAL COCCURRICATIONS USING FIRES.

H. Areasel (REA Laboratorios, Princeton, New Areasel (REA Laboratorios)

Laser diodes and light omitting diodes suitable for optical communication systems have reached a Mage of maturity which makes their practical use possible. Of the two spectral regions of interest, 0.8 to 0.9 um and 1.1 to 1.7 um, the first is the most widely used because the AIGARA double haterojunction devices are the most developed. Hi-ever, rapid progress is being made in the development of the longer wavelength incass/inP dailes. Laser research and development is currently also focused on devices operating reliably in the fundamental spatial mode in order to insure link-free aperation and a single bear far field. Several structures have been developed take operation at power lavels (cw) on the order of 10 th. Several at particular of the developed and Sci. Paper 8081789

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Geodesy and Gravity

1930 High order bermonics of the gravity potential field and local gravity anomalies. BR GRAVITY FILD IN THE CRITICAL PACIFIC PROM SUELLITE-TO-SATELLITE TRACKING large & Hearth (Earth Survey Applications Division Coddard Space Flight Center, Greenbelr, Maryland 20771) Brace D. Harsh, Ronald G. Willismann and William I. Wells

Satelline-to-marcellite Doppler tracking between the AIS-6 and the GEOS-3 spacecraft is used to resture the high degree and order gravity field over an 80° area in the central Pacific Ocean. Doppler tracking provides velocity measurements of CDDS-3 as a function of time which are seally covered to line-of-might accelerations. Since the low degree and order gravity field is known tell, each colline-of-might accelerations. Since the low degree and order gravity field is known to a twelfth degree and order gravity field is known to a twelfth degree and order gravity and the cathod is then capable of measuring wavelengths in the range of from about 500 to 1000 km. Accelerations computed along forty revolutions, "Only by all of them descending and the others ascending. Can be contoured into a men of the rought on Coputed along forty revolutions, results on Coputed along forty revolutions, as as andios, can be contoured into a map of the struit, field at the GEOS-1 stitude of \$50 km. The decimant wavelength of the map is about 1000 to. A coputed into a map of the struit, field with an altitute of decimant wavelength of the self-los gravity lield shows good agraement. Since each map is desuntially independent of the others, this comparison is critical in establishing the validity of any of the maps. Each map shows victually the first accountially the same areas of positive and negative anomaly. The first accountially the same in the concept of the surface applicates these enomalies and only one-tenth as large at the GEOS-1 altificative in a state only one-tenth as large at the GEOS-1 altificative in raidual depth anomalies impice from the cause of case of these anomalies may be the state of the state copy and the upper surface of the light-of-looks. Some of the anomalies apparently do for correlate with residual depth anomalies.

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A MARIE GROWNSICAL STUDY OF THE "COMORN BIDGE".
B. G. KAHLE (Institut für Goodsie und Photogramstria, FRI-Röngschurg, 2001 Frifch, Switzerland)
B. M. Mein, R. Talwani and O. Eldholm
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parallel to the montanest court of helia. This line marks the eastern foundary of a top-graphic and becoment high here named the "Colorent Middee" shock it also charty not need a defined temporal maps the radge mass to act and fatter to the man. The ridge meet to not an afternet to the most a jumman of them softeness of included the most at comparison of the contern (landward) edge of the Comparis Ridge with wirliar structured of other justice continents areging such as those off southern South Africa (Aquihas Practure zone), off the Falkisted Paisons and off western Norway is Bade. It is such took that the castern edge of the content kinds may man a significant extruc-tural entail them. tural cruster is undary. (Marine perphysics, free-arr and tactitatic amounts a, continental margin etrocture). J. Geophym. Res., Red. Paper 6081826

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Geomagnetism and **Paleomagnetism**

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P.O. NO 'VOLTANEAT ARTOURA
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Robert F. ButlertDepartment of Geosciences,
University of Artsons, Tucson, Artsons 35721;
Paleomagnetic data were obtained from mine
cooling units of the lare Createous (*72 Ms;
Roskruge Volcanics and from twenty-five flows in
the lower Paleocene Gringo Culch 'Volcanics, both
from southoantern Arizons. Alternating field
damagnorization successfully erased the infrequent ascendary components of magnetization.
The paleomagnetic pole position obtained from
the Roskruge Volcanics is set 73.6°N, 176.0°C
with dp = 6.2° and do = 3.8°. The Gringo Guich
Volcanica pole position is set 77.0°N, 201.0°E
with dp = 1.2° and dp = 1.7°. In conjunction
with other recently published Poleocene and with dp = 1.2° and dp = 1.7°. In conjunction with other recently published Poleocene and Econome paleomagnetic poles, these data provide datails of North American apparent polar wander during the Laranide orogany (*80 He to *40 He). An episode of rapid apparent polar wander from the Cratacoous pole position in the Baring Strait to the Econome pole position mear the present rotation axis occurred during that interval of time. The initiation of this episode of apparent polar wander appears to be coincident with the major plate reorganizations which occurred at the major plate reorganizations which occurred at the major plate reorganization crogany. (Paleocapetime, apparent polar wander, Cratacoous, Paleocane, Morth America.)

J. Gaophys. Res., Red, Paper 8081826

2500 Time variations, paleomagnatism AMALYSIS OF THE MULTICOMPONENT MAGNITIZATION OF THE LITTLE DAL GROUP, MACHINIE MOUNTAINS, MORTHWEST TERRITORIES, CAMADA NORTHWEST TERRITORIES, CARADA

J.K. Park (Gaocagnestic Lab., Earth Physics
Branch, Dept. of Ecergy, Hines, and Resources,
Ottawa, Ontario, Canada Kia OYJ)

A paleomagnetic study on 14 rad licestone
sires of the Helikian Little Del Group,
'besinal sequence' (Hackensie Hountains,
Northwest Territories, Canada) resolved five

magnetization (C) with low unblocking

magnetization (2) with low unblocking temperatures (<350°C) is probably a gosthite vesthering component of Cretacous age. It gives a direction as 231°,+73° (12 sites, k=73, os;-5°) and a pole at 60°N, 170°K. The other closely related sugmetizations (A. territail) probably carried by sugmetite (A.) and hematike (A.) respectively, yield directions of 25°, -29° (p=8°, os;-4°) and 264°,-26° (p=93, os;-4°) with a costined pole at 16°S, 141°K (14 sites, K-14t, As;-3°). The two remaining sugmetizations (5, red hematite planent?) — a normal (1,) and a reverse (8,) component recognized in most specimens — have a combined direction of 273°-09° (p=17) os;-10°) and a pole at 3°S, 138°K (13 sites, K-26, As;-8°). G and A are profolding (before Paleocens or pre-late Creatacous) with A suggested to be primary. A and B He closa to a recently proposed poler track for the late Helkian and Hadrymian and syddence suggests a magnetization age for A of 90° to 450 Ms. (Falenzagnetism, suggesting, mailtiposponents, Procembrian).

J. Geophys. Ben., Red. 7aper 8081827

Hydrology

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A STUDY OF RESIDENCE THE SAND THESHOSYDBOLOGIC SPECTS OF AN UNDERGROUND ENFOSITORY FOR
NUCLEAR WASTES IN HARD BOCK.
J.S.Y. Wing, (Earth Belence Division, Labrence
Berkeley Laboratory, University of California,
Borkeley, California, 54720), G.F. Teeng, W.G.W.
Gook, and P.A. Witchierspoor.
Fast valeaged by the radidentive deep of Nu-

clear wastes in an underground repository causes a long-term thereof disturbance in the rock resear. The nature of the disturbance for a planar repository 3000 m in dismater at a dopth of 500 m below surface is investigated. Leaded initially with a power deceivy of 10 M/m² of epent fuel areachiles 10 years after discharge from a reactor, the manisum increase in temperature of the repository in granite is about 50°C and the apicentral thermal gradient about 70°C/h. Different waste force and periods before burial have significant offsets on the thormal disturbance. The affects of temperature charges on the groundwater flow are evaluated with alopic models of a vertical fracture connected to a horizontal fracture in the rock case. The buoyancy groundwater flow through the wertical fracture is a function of both the vertical and the horizontal fracture transmissivities, as well as the changes in density and viscosity of groundwater caused by the temperature changes. Finite hydraulic recharge from surrounding rock mass affects the thermohydrologic disturbance. (Radiosctive waste rapository, fracture flow, buoyancy flow, temperature).

Meteorology

3715 Chemical composition and rhemical INTOTACTIONS
HEASUREMENTS OF STRATOSPHERIC SULFATE
HIXING RATIO WITH A MULTI FILLER SAMPLER Sandrud and A. L. Larrus (Saples B. M. Gandrud and A. L. Larrus (Mational Conter For Atmosphoric Pedearch, P. O. Bos 1900, Boulder, Colorado (801).

A new multi filter sampler (MFS) was used to menaure daily profiles of suffact escaped to the daily profiles of suffact asserted in Alesta during the period July 16 through lafty 19, 1979. During these 4 days, the variability is such that the Petron. Brandard deviation of such latterial The results of these flights are compared with the Project Airstroan results from the

3715 Chemical composition and chemical interac-Sions ATMOSHURRIC REASUREMENTS OF CF, AND OTHERS FLACEO-CARBOAS CONTAINING THE CF, GROUPING S.A. Peubett(A.E.R.E. Horvell, England) N.J.D. Prosser, R.A. Rassutters and R.A.K. Khalil (A.M.) Assuntance of R.A.K. Khalil teroful accouragents by GC/ND techniques on simple process of the state of the stat retion to 1479 was constant at ab-69.9 pptr (standard deviation = 7.2 pptv). It is almost certainly produced entirely by emissions Other compounds to the amosphere containing the GP, group have been identified by GP/NS as CF₁, GP(1), GP₀ and Gp₁C₁. The concentra-tions of the first pair are about 4 pptv and the latter two are about 0.7 pptv and 4 pptv respec-tively. The Cpf₀ is produced simultaneously with

with CF_b in the populacture of aleminium. CF_bCl CF_bBr and C₂F₅Cl are probably produced by the The entromental importance of these compounds is discussed in the contest of two papers recently published as CFs by Clerrons (1979) and by bags et al. (1990). (Fluorousbons, slussinus industry, greenhouse effects). J. Gaophys. Res., Green, Papar 8001750

3750 humblings RADIATIVE PROPERTIES OF THE BACKGROUND STRATO-SPIERIC AEROSOLS AND IMPLICATIONS FOR PERTURBED CONDITIONS

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3760 lonic (oteractions and processes REGATIVE ION COMPOSITION MEASUREMENTS IN THE

STRAIOSPHERE.
L. Artja, D. Navejuna, P. Frederick and J. Ingels
(Beigian lastitute for Space Aeronomy, Ringlann J.
B-180 Brunnels, Beigium)
Composition measurements of negative ions in
the stratosphere were performed at altitudes near,
35 km by means of a bailoon borne mans spectrometer during to recent bailoon flights. The
observed ions were identified as mixed cluster
ions of the form 80, nkN03 and 850, nkN03-mis50,
354744ed clusters of both ion families have also
here described. A reaction achone is composed to digitated clusters of both ion families have also been dotected. A reaction acheem is proposed to explain the data. The relative abundances of the ion many peaks is used to derive the number drustry of nitric acid and sulfuric acid in the

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We report their measurements of the sersool content of the atmosphere for the

first two nonths following the volcanic explosion of Mt.St. Helen. The measurements were taken aver L'Aquilafitalyi with a liday ayaren, he measurements are compared to similar days for the previous quieccent period and show a large increase of the tackucattering ratio in the atracognhere and upper tenocophere.Layers have been abserved as various attitudes.A strong layer at 10-thkn has been observed unly initially layers between 11-15th have been observed continually. These features show a considerable day to day varability. (Stratospheric nerosuba, volcanic eruplion, ildar system). Geophys. Fom. Lott., Paper 801.1482

37/0 Particles and muropole
1N-SITU MEASUREMENTS OF SCATTERING PLASE
FUNCTIONS OF STRATOSPHERIC AEROSOL PARTICLES
1N ALASKA BURKEY FLOW 1979
G. W. Gramm (School of Geophysical Sciences,
Georgia Institute of Tochnology, Atlanta
Georgia 10112)
A laner maphilometer developed for althorne

neasurements of pular scattering diagrams of Atmospheric seresals was flow on the NCAS Sabreliner sireraft to obtain data on light eastforing parameters to obtain dark on tight eastforing parameters for extention point, aero-sil particles over Alaska during July 1979, observed values of the angular variation of Acattered-light intensity were compared with those calculated for different values of the Asymmetry parameter g in the Henyov-Greenotein phane function. Our observations indicate that, for the time and location of the e-periconts, the Humsey-Greenstein phase function Could be use to calculate polar contering environtry parameter value of g = 0.49:0.07. Scophys. Res. Lett., Paper Bullions

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Hoster Y. Len and Homan M. Haves (LFE discrepance). Referred distributed objects.

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University of Alaska, FAirbarka, Alaska 93/011 L. H. Shapira for introspondence Principle of Visconiasticity is sculted to obtain the planewake Inculate responde of a laterally compressed viscoelastic plate frosting on a perfect liquid. The typith is analyzed as a wave guide basing a small direction for four-nameder linear viscoelastic notel is used to simulate the characteristics of a sheet of floating ice wiscoelastic notel is used to simulate the characteristics of a sheet of floating ice wiscoelastic notel in the characteristics of a sheet of floating ice characteristics of a sheet of floating ice are used to produce illustrative examples of the displacement and the variosl loading stress causel by the tending produces in an ice areas. the displace-ing and the vertical loading is caused by the benius produced in an ice steel a plane wived arising from a unit line force raing uniformly across the ideal. Decause the displacement of the viscoelastic plate ramping injute, this technique provides a mains for making engineering assistates of the stress produced by makes at the critical frequency.

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Particles and Fieldslonosphere

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This pipes presents and discusses ion hoperature and suprathermal electric flue data acquire-

with fine retaiding potential analyzer on board two Cyon-A mightists when it was in solar collipse Accomming to directed to reasystemic in the 440-860 on height interval between planight and Attention is directed to respective to the Art. Art on helph interval between windight and product in the morthern winter monoids and product in the morthern winter monoids indominate in the morthern winter monoids dowling a t-rooth time span precise a decoupling of the fractural and attitude effects. A distinct longitudical world to be never for the territorial world to be no significant refactive entrancement cost the western morth Allantic. Alicitude distributions of four temperature are repartible with Hillesone Hall profiles within the retirent regardle whethough all profiles within the retirent regardle whethough are described in the retirent regardle whethough are observed and extend to ruch lower geomographic latitudes in rible are longitude measured for the indication of constitution and a strong abiliarity in startle rated are decompared for these in attention of the intitude was a longitude. The location of the whether fluxes is warfable, deposite on local line and messon as well as longitude. Warfardlen in this boundary for shortful fluxes is warfable, when the many of the distance on well as longitude. Warfardlen in this boundary are found consistent with a calculated conjugate solar rentile ergle of vie 2.2 describing photoproduction of summotic electrons in the southern bringshore. The good data was considered indirected for summor hemisphere, and providing heat was attacked for the photoulastrons to a broad but proformatial segment of the winter nighting are without access to this energy source and confident for the beautiful temperature at higher to allow the first of the photoulastrons to a broad but proformatial energy to the winter nighting are without access to this energy source and confident and with the product and towar the beautiful temperature at higher to

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3500 Inservants and techniques in the 1900REPERT SCATTERING OF PAGAR MAYES IN THE S. Leriet Bater (Space Physics Pescarch

Libratory, University of Michigan, Am Arbor, Pichigan J.P. Schmarton, F.S.B. Ong We have systematically studied the effects that -neMagnetition and releasely distributions projuor the limbs cart of the spectros of radar wave ic' meanth, memorated from the disturbed bigh Batte to I musphage on the upper E and lower F regions. For two to electron resperature ratter trater than, or equal to unity and electric field strengths greater than about 10 ml/m, the section is fortuned distorted from the shape

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that it would amenativ have if the ion velocity distribution are Hervellian. In events where the expension pheric convection electric field not reads 10 m/m the interpretation of the data is affected if the erroneous assumption of a Misswellian distribution is used to analyze the data. The electron torperature is the property most seriously affected by the erroneous interpretation, as it as he underestimated by an enchance of a factor of 2. Finally, the spectra data industry the spectra height conditions are animateropic, with the least distortions from a Narwellian-type spectrum heigh found along the engagetic field direction. The apparent ton temperature were along the line of sight of the tolar as it acam from perallicities to meanly perpendicular, in the assguete field also increases as the analys with the tangestic field increases, even for D.C. electric field strengths as socil as 20 m/m.

J. Geophys. Rea., Blus, Paper BUA1798

Particles and Fleids-Magnetosphere

5710 Asgnetophuse
STRUCTER OF JUPITER'S MACRETOPAUSE: PIONEER 10
AND 11 ORSERVATIONS
B. Sommarup (Gretcauth College, Hanaver, 24 03755
U.S.A.) 2. Soith, B. Tauratent and J. Wolfe
The engastic structure of Jupiter's magnetophuse, as observed by the space probes Flones 10
and 11, is compared with torrestrial magnetophuse
structures from the OGS-5 mission. The jovian
magnetophuse thickness, deduced from a rapid rriplo creating, is found to lie in the range 15001200 km, while the adjoining plasma houndary
layer was 1500-8400 for thick. Comparison with
the terrestrial situation suggests that the dayside engastophuse thickness in both cases to a
few rices the lon gyruradius and that the dayside engastophuse includes in both cases to a
few rices the lon gyruradius and that the dayside ongostophuse includes in both cases to a
few rices the lon gyruradius and that the dayside ongostophuse includes a blood and proposition to
the file ongonent are determined for each crossting by use of sinitum variance anniyais. The
results indicate a blood and licepp charactophuse
matrix in sident in the component of the file one
and the indicate a blood and licepp charactophuse
displayed the characteristic features of a rorational discontinuity. Such atturbures are cornalmential also near the satth's magnetophuse,
and are greenably associated with an open freconnectified regarduphore. Some of the jevian
crossing also display other features that have
been characterial to watch intital tiel conction in the 'urang' sense at the outer edge of
the cagnetophuse discagnosity effects and fieldsilved currents at the inner odge of the plasma 17 19 Regnetopause STRUCTURE OF JUPITER'S RACHETOPAUSE: PIONEER 10 the taggetopause; discagnosis effects and field-situated currents at the inner edge of the planus boundary lever. (Magacropause, Jupiter, Plonoer

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.747 Magnetospherts configuration of the recognition of the recognitio From Formal and James D. Saillyan (Center for space Received, Mysachosetts institute of technology, forbridge, Mysachosetts 021)91.

A model of the to playes forms have been constructed using the first steplasm measurements of the formal of the first steplasm measurements of the formal of the first steplasm that the formal of the first steplasm that for the formal of the parts, a rold inner factor where the ions are loosely confined to the contribute and a step outer teglan which includes the orbit of 10 and him a thickness so the height of 10 j. The other state of the step state of the same total defined by a deep on him a Chiemen on the height of 1 Pj. The story adjace in the harm totus is during by a drop in planes density mear 1.5 %. The bulk notion if the planes, i.e., the average valuative vector, is within 12 of the value expected on the basis of artist corotation in the inner part of the arms but protable do later by 5 to 10. From artistion corotation in the inner part of the arms and the carried of the corotation and occur at the outer boundary of the warr totus. The shorty per charge spectra how well-recolved goals to the inner part of the torus but strongly excellent peaks in the inner part of the corotation to he shouldness of different testic and that in the shouldness of different testic energial means of different testic energial means are different testic energial means of the most opening of the middle magnetosphere the context comments of the middle magnetosphere the the places where of the middle magnetosphere the function monastion appears to be uniform from 12 to 12 Pg and is account deminated by ions with a ratio of accute mass to oberge of 16. These tone are most probably some confination of 10° and 8.24 kms. One topsequence is that the Alives speed is uniformly like in the outer part of the torus with values less than 250 km s⁻¹. J. Geophys. Res., Blue, Paper 80x1345

3/35 Plasma instabilities GENERATION OF WHISTLER-MODE SIDE BANDS IN THE

CHEMITION OF UNISTICE. MODE SIDE BANDS IN THE MACHETOSPHEE AND SIDE SAME (Raisscience Laboratory, Stanford Physicalty, Stanford, Ca. 94305, U. S. A.)

VIF translitter experiments conducted at Siple, Antercice (L * 4) show that long (%1 asc) keydown signals injected into the magnetosphere often genorate wide bands as "result of non-linear interactions with emergenic particles. The spectral characteristics of observed side bands are quite varied and complex. The side band irequancy spacing varies from "2 Hz to 100 Hz, but it hears no simple relationship to the carrier amplitude, in sharp contrast to the predictions of some theories. The side band amplitude is usually 10 dB or nows below the carrier septimently 10 dB or nows below the carrier ampliusually 10 do r nove monover carrier sup-tude, but sometices it can exceed the carrier amplitude and also trigger emissions. Multiple side bands are often observed, and their fra-quency separations from the carrier may or ray not be harmonically related. Side bend supiltuins may be symmetrical or segmentrical abou usually the upper side band that is stronger. Various side band generation sechanisms are dis-

date. 1. Geophys. Pess, Blue, Paper 80A1823

OBSERVATIONS OF QUASIPPRIODIC FLUX VARIATIONS OF INTESTIL 1698 AND SLECKFONS ASSOCIATED WITH FC 3 CHMCHATTE PIJATIONS

C. Kreuser (Maz-Planch-Institut für Accommite, D-ball Katlanburg-lindau J. FED.) A. Korth,

i.A. Fejer, S. Wilton, A.V. Gutavich and C. Anata Simutaneous quesiperiodic variations of electrons (E. 22 bol), some (E. 27 heV), and the geometric Sinis in the Fe 3 pariod vange were cheaved emboard the geometricary satellite close. 25 avants occurred between August 1978 and July 1979. For types of events could be distinguished. During the (first type electrons and some reached their flux maxims and mindman simultaneously ("in-plane events"). During events of the second type the electron link had mindma at the ion flux maxims and vice verse. The in-phase seems of the preferratially around noon. They had longer everage periods and durations than the out-of-phase events that appeared around dust. The phase vents that appeared around dust. The phase vents that appeared around and song was found to depend on the slope of the selectron pitch apple of the selectron of the select

predictions of the drift mirror instability theory. In terms of this theory the two different types of quasiperiodic events can be regarded as the result of different responses of the electrons to the disturbance conditions around noon and dusk. The drift mirror instability is associated with drifting energatic proton bunches that apparents Affect waves. An estimate of the wave amplitudes yielded values similar to those actually cheerved. J. Geophys. Res., Blue, Paper 8041720

5760 Plasma motion, convection, or circulation POSITIVE ICH OBSERVATIONS IN THE WINDLE MAGNETOSPHERE OF JUPITEP R. L. Momutt, Jr., J. M. Beloher, and M. B. Bridge. Department of Physics and Center for Space Pescarch. Cambridge. PA 21391 We consider the positive ion data gathered by the Voyager Plasma Science experiment in the middle magnetosphere of Jupiter. The experiment measures positive ions with energies per charge between 10V and 5950V. The observations are analyzed to obtain the mass and charge domalties, velocity components, and temperatures of the low enterty plasma population. The reduced data set is discussed in the context of the outstanding questions concerning this plasma population and its dynamics. We find that on the dayalds, there saists a transonic to highly supersonic positive ion population which tends to move ambuttally but does not rigidly corutate with the plasma. These lone provide the inertia of the sugmetospheric plasma inside of "40 Rg. The meas donairy is everywhere dominated by heavy lone and the measurement of the first plasma inside of "40 Rg. The measurement of the supertospheric plasma inside of "40 Rg. The measurement of the magnetospheric plasma therefore the inertia of the supertospheric plasma inside of "40 Rg. The measurement of the magnetospheric distribution from the loplasma torus via flux tube interchange. The lone torus via flux tube interchange. The lone torus of the magnetic laciation is calcively cool ("20 eVI compared to plasma in the sheet is relatively cool ("20 eVI compared to plasma to the dayalds and toward the current sheet on the magnetic flow beauting the magnetic plasma sheet is premably driven by the saymmetry in the magnettaphere due to the soler wind interaction. J. Geophys. Res., Size, Paper 80A1602

SYOO Plusma motion, convection or circulation QUANTITATIVE SIMULATION OF A "MAGNATOAPPIRATE SUBSTORM, I. PLASMAPPINATE ELECTRIC VIKLOS AND EVOLUTION OF THE PLASMAPAINER. R. W. Spiro (Department of Space Physics and Astronomy, Rice University, Houston, 72 (770h)) it. Harel, R. A. Wolf and P. W. Reiff Results of the Pice University, Houston, 72 (770h) it. Harel, R. A. Wolf and P. W. Reiff Results of the Pice University substorm simulation have been used to investigate the ponetration of substorm-associated electric fields into the plasmasphere. Many A Ry in the equatorial plane, our time-dependent electric field model is characterized by seatured components in the dual-midnight local time sector and agricult components after midnight. Except for a small region just before dusk, the model predicts centured electric field components throughout the davide electric field components throughout the davide electric field components throughout the davide ascion. The characteristic radial component is diversed inward at all local times accept for a small region just after dawn. Home remults obtained during region just after dawn. Home remults obtained during associately disturbed periods.

By assuming an initial plasmapsume ahape and by following the computed & x h drift trajectories of plasma first tubus from the first initial houndary we have weakined the short-term evolution of the plasmaphuse during the substorm onset. These tailing appendices to the plasmasphere meandusk within hours of substorm onset. These tailing appendices to the plasmasphere aubsequently drift rapidly from the dusk sector toward the daylone angecopause.

drift rapidly from the house scale time-dapendent invastigation of the large-scale time-dapendent flow of plasma in the swening sector indicates that two nid-latitude plasma flux tubes that drift sestuard past the dusk terminator rewerse their sorten between dusk and indight and begin to drift; westward toward dusk. Such time dapendent changes in flow trajectories may be related to the forestion of freedom lenization troughs.

3760 Plasma motion, convection or circulation QUARTITATIVE SIMULATION OF A HAGNETOSPHERIC SUBSTORM, 2. COMPARISON WITH OBSERVATIONS M. Harel (Department of Space Physics and Astronomy, Rice Mitvarsity, Houston, IX 77001) R. A. Welf, R. W. Spiro, C.-K. Chen, W. J. Burks, V. I. Rich and M. Saiddy Saversi results of the computer simulation of the behavior of the inner megnetosphere during the substorm-type svent of 19 September 1976 are discussed in detail.

the behavior of the inner magnetosphere during the substore-type event of 19 September 1976 are discussed in detail.

The model predicts a modesar ring-current injection, in to 1 = 0, with total strength that is comparable to the strangth estimated from the observed decrease in Der. For the geosynchronous-orbit region on the duck side, the model predicts a characteristic energy dispersion often observed by fillwain and collaborators: energetic ions errive first after substorm onset, followed by less substored ionset, followed by less substored ionset, followed by less substored ionset, although there are destiled differences. These general lestures on which the model and observations are in good agreement accet (i) the magnitude and direction of the high-lestured electric field; (2) the degree to which the low-latitude

ionophers is shisland from the high-latitude convection electric field on the dusk side is significantly larger, on the average, then the squaterward electric field on the daws side. The observations indicated one instance of rapid flow equatorward of the sureral zone, involving an electric field of sore than 100 mVm. This rapid subsureral flow was accurately predicted by the endal.

autourceal flow was accurately predicted by the model.

The predicted essat-west magnetic perturbations due to region-2 Birkeland currents agree satisfactorily with 53-2 observations with regard to direction, total magnitude and general location, but there is an important general discrepancy; in most cases, the actual Birkeland currents were distributed over a wider range of latitude than the codel would predict. Specialations are presented as to possible explanations of the discrepancy.

The model Birkeland currents agree satisfactorily with the averaged observations of lillum and Fateurs, in turns of direction, strength saw overall pattern. The model suggests a theoretical interpretation of the observed overlap region near addelight, where a region of upward Sirkeland

cal interpretation of the observed overlap ragion near addight, where a region of upperd Sirkeland current is bounded on its equatorward and pole-word sides by regions of downward corrent.

The model provides a special picture of the overall magnetosphere-tonophere current system. It also seggests that the observed saymetry in the change of the horisontal magnetic field at low-letitude ground stations during the main phase of a magnetic store should not be interpreted simply as saymetric development of the inner-magnetospheric ring currents and the sesociated region-2 Sirkelend currents. Region-1 Sirkelend currents. Region-1 Sirkelend currents, to the outer magnetosphere, play a major role in the asymmetry of low-letitude AH, white overhead Hall currents seem to play a lesser role.

of low-latitude MH, while openhead Reil currents asses to play a leaser role.

The model indicates that the rotal Joule heating during the event is - I times the increase in ring-carrent energy, a result that is in experant contradiction to some provious duti-wates. A general, but highly approximate, analytic ergetest is presented in support of this yearst pf the simulation. Some shaple formulas

Sido Plasas sotion, convection or circulation symmitative Sinulation of a HampetoSpheric Sustion, i. Model Logic and overfith Sustion, i. Model Logic and overfith and in Savel (Department of Space Physics and M. Bavel (Physics and M. Savel (Physics Av.) J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. A. Volf, P. H. Reiff, R. V. Spiro, W. J. R. Reiff, R. V. Spiro, W. J. Reiff, R. Reiff, R. V. Spiro, W. Reiff, R. Reiff, R. V. Spiro, W. J. Reiff, R. Reiff, R. V. Spiro, W. J. Reiff, R. Reiff, R. V. Spiro, W. Reiff, R. Reiff, R. Reiff, R. V. Spiro, W. Reiff, R. Reiff, R. Reiff, R. V. Spiro, R. Reiff, R. Reiff, R. V. Spiro, R. Reiff, R.

tions. Other was as a constructions. Other was the conduction tipe dependent magnetic field and conduction to the state of the state of

Non Plant Cation, convection, or circulation in STERMS in THE INDESTINAL.

P. N. Sharp, B. L. Care, U. N. Paterson, and E. G. Shelley incheed Palo Alto Research Laboratory.

131 Henover Street, Palo Alto, California;

Ton case spectrometer observations of low temperature streading plasmas in the earth's exameter, this are reported. Heasurements in the energy percentric radial distances. 21 p. from the INFE-1 spacecraft. Ion streams of anidar Lind origin in the test industrial stream of anidar Lind origin in the test longer and of innospheric origin in the tail tobes and plasma sheet are described. A statistical study of come of the characteristics of the streams allows us to infer that the central tail tobe plasman are primarily constituted of long streams of (consepheric origin sed that the Concemperation of (consepheric origin sheet, not the box plasmas that for the plasma sheet.

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Sivo Planza notion, convection, or circulation 942/94 castsvarious of THE MLPVIN WAVE 2007-2018 by 10 J. V. Beicherlepartment of Physica and Center for Space Research Wir, Cambridge, MA 07139 c. L. woorts (Naw-Plank) invested for Space Research VIII, Cambridge, Th. Arsnockel Katlanburg-Lindau J. V. Germmy, J. D. Sullivan, (Department of Physica and Center for Space Research WIT, Cambridge, Th. S. N. Acuma Maboratory for batraturnsutal Physics) Goddard Space Flight Centur, Greenhelt, The Beau examined the changes in positive ion flur observed by the Veyager J Plasma Science instrument near the 10 flux tybe. The measurements are consistent with the detection of whichly presupations in the magnetosiphoric flux due to the seculoscipt propagating Altván Wave generated by fo.

flow due to the southwardly propagating altern wave generated by fo.

This conclusion is based on a theoretical similation of the december response unine: [1] the planes densities and temperatures derived from the inhouse observations at the following the inhouse observations at the following the inhouse observations at the following contends may be observed the propagaty perturbations derived theoretically from these magnetic field perturbations, using the examined and Alven have relations. This simulation produces faults which are qualitatively in appointment with the observations. In particular, the George flues are only consistent with a bouthwardly propagating Alven wave.

J. Geophys. Res., Blue, Paper BOAL542

3770 Short-period (less than 1 day) variations of

170 Short-period (Lene than 1 day) waristions of Exquite 1 leid ALFYET MAKE RECORDINGS IN A REALISTIC MAGNETO-SPECIE MAGNETO FIELD GEOMETRY B. J. Singer Debt of Ameronomy, Bondon University, Bonton, NA 02213) D. J. Bonthwood, R. J. Walter, and M. G. Kivelmon The notion of magnetic field line resonance has been very effective in explaining many features of long-period secongnetic pulsations. To date the decoupled transverse wave equations have been solved in a cagnetic dipole field whereas only a speciality of the decoupled in order than the decoupled transverse wave equations have been used in note colved in augmatic dipole field whereas only will a superior dipole field whereas only will approving solutions have been used in more steman general augmatic. It descripted augustions in a general augmatic field general such adding the effects of density fielding the effects of density and case exceptation. The sim of this paper is to include and examine the effects on eigenfrequents of only the field geometry by keeping is not the district and examine the effect on eigenfrequents of only the field geometry by keeping is not the district augmatic and in space by using the fetent discovering the field geometry is larger than a factor of 2. At 6.6 kg, where the displeited in provided the to field geometry is larger than a factor of 2. At 6.6 kg, where the displeited in the incovering the magnetism in period due to field geometry is larger than a factor of 2. At 6.6 kg, where the displeited in the incovering the magnetism is period of the field geometry in the equator in first of the sample of the plane is appeaded on only at distances 10 kg. 100 k

Physical Properties of Rocks

SiD Risattery, fracture, and flow ACMSCOSTE MODEL FOR THE AMESOTROPIC BLASTIC MODEL OF LESS OIL STALE AMESOTROPIC BLASTIC John B. Rundle (Stripton 554), Sandia Laboratoriza, Aboust Laboratoriza, Maria Jahan Sandia Laboratoriza, Maria Laboratoriza, Maria Jahan Sandia Laboratoriza, Amesia Jahan Jahan

the namepherical shape of the baragan inclusions. Six parameters are needed to quantify the model fully: two electric codult for the heat rock, two for the inclusions, the barages content, and the inclusion sepect cario.

The model is compared to a set of statically measured electric modult. Good agreement with less oil abais data was found. However, note systematic differences agreer is comparison with nodult measured withrespictedly. sured ultresonically. Geophysics, Vol. 46, No.2

6110 Elasticity, fracture, and flow PREQUENCY DEPENDENCY OF SEISHIC DISSIPATION IN SATURATED ROCKS

B. R. Tiltmann (Rockwell International Science Center, Thousand Cake, California 91360)

H. Radler, V. A. Clark, L. A. Abbarg, and

T. V. Spencur.

Measurements of the specific dissipation factor, Q-1, baye hose made in saturated rock as a function of situative pressure. The measurements were cade at two different frequencies, one in the tange of 100 to 250 Hz and the other in the range of 7 to 9 blls, using the resonant ber unthed. In saturated rock, Q-1 is lower at the lower frequency, and the difference between the values of Q-1 onsewred at the high and low frequencies decreases as effective pressure increases. At effective pressures greater than 200 here, the Q-1 saturated Beres sandstone seasured at 200 Rs approaches that of dry Berca sandstone seasured at 7 kHs. Isolamic dissipation, saturated cock, frequency decondence) (requency dependence) Coophys. Res. Left., Paper 8011204

610 Elasticity, Fracture, and flow PROPAGATING EPISODIC CREEP AND THE ASELSMIC SLIP BEHAVIOR OF THE CALAVERAS FAULT NORTH OF HOLLISTER, CALIFORNIA K. Evens, R. Burford (Office of Earthquake Studies, U.S. Geological Survey, 345 Middlefts Road, Memlo Park, CA 94025, USA) and G. C. P.

Road, Memlo Park, CA 94025, USA) and G. C. P.
King
A detailed kinematic study of fault slip occurring from the surface to a depth of about 7
km on the Calaveras fault north of Hollister was
conducted during the summer of 1977. The observations coincided with a period of probagating appead of full creep activity sensed along
the fault trace. Data used in the investigation
consist of creepmeter records, near-field scrain
meter observations, and high-resolution geodetic
measurements, all collected contemporaneously
over a period of four months. Detailed descriptions and analyses of the Creepweter and geodetic
data have been presented elsewhere. The nearfield strain measurements are here reported in
detail and their analysis draws upon the previbos two data sels for support. The strainmeter
observations are most sensitive to slip occurring in the upper two bilometers, hence the the
phasis of the paper is placed upon the role of
propagating episadic creep in the broad-scale
behavior of the fault.

The results suggest that propagating appisodic

propagating episodic creep in the broadsast penaritor of the fault.

The results suggest that propagating apisodic fault creep as sensed along the fault trace is contines to the upper kilometer or so of the crust and represents the response of the surface layers to a longer-term form of episodic aseismic slip occurring below. The mean (on of the advancing cupture front within the upper is longer is usions by the same as that indicated by records from the surface creepmeters. Evidence is presented, however, which suggests that propagating creep events may not always break the surface, and may propagate at velocities may hybride and at amplitudes significantly larger than those generally observed at the surface. (Fault greep, mark field strain, slip propagation).

ATTO FLANGELETEY, Fracture, and the ULTRASORIC VELOCITIES IN CRETACHUS SHALPS FROM THE HILLISTON BASIN

WILLISTON BASIN
Luone E.A. Junes (Department of Geology and Geoheales, University of Misconsin, 1715 Kent Basin
stort, Calisan, 17 June Herter, 1888
Compressional and Geography valocities were free
world in the laboratory (700) but to 4 khar confining pressure (at cet, undrained samples of
Creaceous shales from depths of 1200 and 5000 ft Timbs pressure (at set, undrained amplies in Creazeous shales from depths of 1200 and 5:00 ft in the Milliston brain, North Dakota. These whiles behave as tremsversely isotropic abstic sedia, the plane of circular syrcotry coinciding with the badding plane. For congressional waves, the velocity is higher for propagation in the hedding plane than at right angles to it, and the aniestropy is greater for the 5000-it shale. For shear waves, the 30 may perpendicular to bedding and the 31-wave parallal to hedding propagate with the same speed which is about 35 percent lower than that for the 100-wave parallal to bedding, to general, compressional and shear velocities are higher for the industed 5000-ft shale hadding, to general, compressional and shear velocities are higher for the industed 5000-ft shale. All velocities increase with increasing continuing pressure to 4 bar. The 1200-ft shale sabibite velocity hysteresis as a function of pressure, whereas this effect is almost nonenistent for the solution of effective pressure and the dependence of velocity on pressure can be explained by considerations for both shales, laboratory compressional wave valucities are on average 10 percent ligher than log-derived velocities. The discrepancy cannot be applained completely, but likely contributing factors are sampling bian, velocity dispersion, and forwardion damage in situ.

Gild Elasticity, fracture and flow NYAMIC AND STATIC MODUL!
C. H. Cheng (Neasachusatta Institute of Technology, Cambridge, leasachusatta 02139) and Gavid H. Johnston
Static and dynamic bulk moduli (Ng and Nd) are measured as continuous functions of gressure from the continuous functions at the C-2 kilders for two sandatones, a tuff, timestone, granita and oil shale. Results for the sandatones and gradice are in good Expressent with proviously reported data with Ng/Kd varying the sandstones and graite are in 300s syrements with previously reported data with K_R/K_A varying from about 0.5 at atmospheric prossure to close to unity at pressures 2 vilobers and above. For rucks behaving elastically under static loading, that K_R/K_A ratio is invertedly related to the Microcraft density. For the limestone, time Microcraft density. For the limestone, time Microcraft density. For the long-tone, time Microcraft density and indexing, while initially high pressures. Upon unloading, while initially high pressures (1.0) at high pressures, K_R/K_A becomes lower then values obstained during loading at low pressures (1.1 kitobar) due to opening of microcrafts generated during pore collapse. For the cut shale, in which few microcrafts gaint, K_R/K_A remains relatively constant with pressure at a value of about 0.1.

Geophys, Res. Latt., Paper 501,1584

CIIO Electicity, fracture, and flow MONLIMEARTY IN ROCK: EVIDENCE FROM EARTH TIDES DONCAN CAFF Agrew (CIBES, Campus Box 449, University of Colorado, Boulder, CI 80309)

The Farth in simusoidally streamed by tidat forcan; if the streamestrain relation for rock is nonlinear energy should appear in the earth tide record at frequencies which are cultipled of those of the larger tidal lines. An examination of the signals to be expected for different tion of the signals to be expected for different nonlinear deformation laws shows that for a non-nonlinear deformation the shows that for a non-linear deformation is shown that for a non-linear deformation is shown that for a non-linear deportment of the should be should occur at twice the force anomalous signal should occur at twice the force anomalous signal should occur at twice the force that should be should be should be should be should be should be particular which dissipation established on the signal in the should be should be prepared in the apparent of response, being measured. For examples on the sample of the should be prepared throughout the forth or localized around the point of measurement, or localized around the point of measurement, are flower flow. Free off-errain tide practices are flower flower free flower of the largest (H.) near at twice, the free should be signal, that the

evolutined by leading from nonlinear vater times in the Gulf of California and the Pacific Grean; the residual nonlinear tide to by the loss tide. The signal at three times the Highest programmy is compatible with a linear modal or with nonlinear hysteresis loops provided that nonlinear dissipation occurs throughout the Earth. Nonlinear dissipation in the rocks near the exclusions a larger signal. the attainmeter would produce a larger sign . Gaophys. Res., Ped., Paper 8081314

A120 Equations of state EQUATIONS OF STATE OF CHU UNDER STATE C PRESSURE

EQUATIONS OF STAIL OF CAN UNITY STATE PERSONNEL COMPITIONS

J. F. Marrane, M. B. Blo, and P. M. Bull timephysical inforatory, Small Upren St., N.U., Unshington, D.C. 20083

Fapor immuol static high-prosente data on the
solute equation of state of the Bi and B? phanes
of Cao in the range i bar-550 bear agrou with
existing low-presente data and with an equation
of state calculated from stock-wave experiments.
The density of the B? phane is close to that of
the lower mantle, so the properties of Lan could
be consistent with theories of the earth's fornation by inhancements accretion. (Cao, pressure, EOS, mantle).

Geophys. Res. Lett., Paper 8011731 Geophys. Ros. Lett., Paper 80/1733

Pianetology

6610 Atmospheres of planets ECHATORIAL ANGMALY IN THE JOVIAN LONGS-PARRE
6.K. Manajan (Mational Physical Labo-ratory, New Delhi, 110 Ole, India)
The electron concentration data from Pioneer 10 and 11 and Voyager 1 and 8 indicate the presence of equatorial annealy in the Joylan ionosphure, with the peak electron concentration value showing a minimum near the equator. (Ploneer 10 and 11, Voyagor 1 and 2, equatorial annealy, Joylan ionosphere).

6540 Suprace (first km) of room
100 IN THE Polar Pecifics OF THE Bong
2. J. Lanzerotti (tol) Indepartment Marroy (kill,
Rele, 07974), W. J. Brown, and R. F. Johnson
Potent Inbordary nonsurregular of the ofonion
of Min ico are used to estimate the loos rates
of possible timped "estimate the loos rates
in possible timped "estimate" in the rold
tuner pular regions. We conclude that a
significant according of water like is unlikely
to occur. Thou, supracering itests.

5575 Surface of Planets SPATIAL COLOR VARIATIONS IN THE VOLCANIG PLYNE AT LOXI, ON IO LOKI, ON IO

Securit A. Collins that Propriation Lab., Calil.

Inst. of Tath., Fassdana, Calif.;

Multicolor Voyager I photographs of the Lobi
volente plume on io, Indicate that the plume
consists of two particle populations, one with
radius 0.001 us - 0.01 us and a second with radius radius G.001 in a collision of smaller particles in-cludes most of the particulate saws in the plan-riance work increases the previously entisated par-ticulate mass and suggests that 50 pes, observed over Lot veltage in the same particulate from the veltage interest of an atmosphere in atta-bia squiithrium with the surfare. [10, Particuletes around Jupiter, Atmosphers - lo.)
J. Goothys. Res., Red, Paper 505/515

6599 Pignetology-General or Historia mesons D.C., 1114 G-89907 Stylenco 1. Lebianc and f. Gangla, ubset. it is de dario, Section diaetrophysique de Meudon, 1914 Meudon,

France.
By using the high resolution observations of tempsy observator, we have been able to identif, the 3-burst embed on the Planator, Radio 4stronomy (PRA) records of Voyager. It was observed that the 3-bursts occur in the regions of the 5-LPP plane (5-108 and 5-104") regions? In that the S-bursts occur in the regions of the full plane (S-lo8 and S-lo8's regions). In these regions the S-burst s-lesion is arranged into a pattern of repatitive features defifting negatively. These features could be ancomplete worter late arcs. As show that the S-burst pattern is distinct from the pattern of the lo-cavital amission. These results are discussed in the frame of Siddlesin and Thieran's arc -3del. J. Geophys. Res., Size, Paper SOA1772

Seismology

6950 Saismic sources (mechanisms, magnitude, fra-quency spectrum, space, and time distri-bution) CARDIQUAKE FOCAL MECHANISMS AND TECTORIC SRO-CESSES ALONG THE SOUTHERN BOUNDARY OF THE CARIS-

CESSES ALONG THE SOUTHERN BOUNDARY OF the Control ELM FLATE.

A. I. Kaika (Lecunt-Dobarty Geological Observatory of Columbia Deliverality Patiendes, "See York 1984) and D. J. weither
The focal mechanisms of five small earthquakes the focal mechanisms of five small earthquakes to so, "5,61 that occurred in morthwatern seementh have been datorminad using telescented have been datorminad using telescentially recorded Rayleigh waves. The Rayleigh wave dates were also used to constrain the depths were date were also used to constrain the depths with the southern boundary of the Caribbean plate to presently characterized by a broad some of internal deformation where the seathward displacement of the Caribbean plate with traspect to placement of the Caribbean plate with traspect to the South American plate to being accommodated the South American plate to being accommodated placement of the Ceribbean plate with respect to the South American plate at being accomplated attack articosty or iented strike-slip fault. This etrike-slip fault. This etrike-slip fault of presentating zones of weakman such as the Sound fault, and the earthquakes studied here are all consistent with an east-west trending compressive stress field being released along theme annual complete its led being released along theme annual complete the tertonic stress field generated by the eastward motion of the Ceribbean plate as opposed to relative plate motion per as. Thus, the could be relative plate motion per as. Thus, the could be relative plate motion of the transform feult. Spreading tenter, or subducting month. Instead, relative plate motion in this region appears to be accomplated by interest deformation within a broad none extending from the interior of the Caribbean plate into northern South America. (focat mechanisms; surface waves, plate tectonics, Cartbean)

J. Geophys. Ros., Rod. Paper 8051874

6970 Structure of the crust and upper manufe SIDMANTARY AND CRESTAL VELOCITIES IN THE ROBBLIAN-GRENIAND SEA A.M. by he (Department of Loology, University of Delo, Norway) and Q. Zidholm Refrection and vile-angle reflection velocities. From the uncanic crust and the overlying mediannia in the Murselson-Treadled Soakare beam malyzed. There is a relatively sapid increase in velocity with depth in the uppermost analyzed, whereas a low constant gradient in representative of the main enduent sequence. The cannot have not the sold the sequence of the pain and the requested the product of the sequence of the pain and the sequence. The cannot part of the basins, have particularly high velocity gradients, "It so 43? and the sequence of the first se

Sea ares 3.88(2A), 5.38(2B), 6.05(2C), 5.66(3), and 7.80(4) in/a. Layer 2A is ago dependent and has not been observed on crust older than 16 m.y. The bods! I in not representative of the uppermater or the upper that to introduce Additional layers or assets continued to introduce Additional layers or assets continued to introduce Additional layers or assets continued value in a change of the America. tinuous velecity changes with depth. J. Go.phys. Pre., Red. Paper 8081829

Solar Physics, Astrophysics, and Astronomy

Planting of the contest of the conte

THE HOLD INTERPORT OF THE PARTY TERMS AN EXECUTE TO THE FPR CO-CREATIONS CONTOUR WOMERS I'M CLOSC II Réfection A. Leonomou (Domes Assesse de Pointes, 9:120

A Learn-House (House satisfies de Mesdam, 9,190 %, sectore le contrat de Mesdam, 9,190 %, sectore le contrat de mandate propagation of the topologic le contrat de mandate de la chiefe de formation et determine de la chiefe de

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Tectonophysics

8190 Plate tellonics NOW CHIFORS SELECTION SLIP RATES ALONG THE HIDBLE

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AMERICA INSICE

AMERICA INSICE

Karen C. Willi (Sciencolngical Liberator).

California insitute of Technology, Parlian,

convergence cates on the serings but ratch than

locally (e.g., Gazece). Along the Coroe-North

Acatis plate boundary, this can be explained by

nonunifornities in aith or points of assimit

tidge or fracture zone subduction. For at least

if years (and possibly several hundred years) co

callor (M. > 7.5) shallon servingshe to know to

have occurred user the Gravio Fracture Zone and

Tehnancec Ridge ateas. Comparison with the

average recurrence porlock for large synthoushus

at 13 ± 5 y, since 1898 out 13 ± 24 y, haven

1542 and 1978 suggests that esther a large

(M. > 3.4) event say he anticipated at such

locations, or that those are points of satisfic

subduction. At leavet three Latine terraces of

probable recont age are found on the count hear

the Orocco Fracture zone, which may point to

large infrequent parthquibles. The larger dis
cropancy between plate convergence and assistic

still years slong the Coroca-Carlibboan plate

Boundary is bore likely due to decoupling and

downbending of the subducted plate.

We use the Histed statistical evidence overit-

housedary is bore livery and to machops and to the householding of the subducted plate.

We use the limited statistical evidence avaitable to chistocatis both parish and temporal delicionates in respect makents sitp. The observations appear combined with a possible forthmoning opineds of mire intense usismic activity. Fland on a sories of comparisons with caryfully deliminated afterselect, names, we canclude that the gone of amoralous solumic activity can be identified by a systematic, automated analysis of the worldwide earthquake ratains (K. 11. 12. Geophys. Res., Red., Poper 8081713

Voicanology

8492 Toleranders tophics POSSINE TRANSCRIES WOLCOME CREURBLUTES OF CAR CLATRATE HIDATES Franci S. Deffray the Alamon Scientific Laboratory, los Alamon, MR 87945)

Interprote, ion Alances, MR 87945;

On the hank of the thermodynamic stability of bridges of 50g. 1925 and COs. It is superbate that there are no consists and cost in superbate that there are no consists. Reference of 50g and 1928 may be found in low-tasperature immediately. Superbate where arrounding rocks are helps 87. Superbate where lattendes. Hadrates of 95; 50g, and 70g and better a high altitudes, and/or high lattendes. Hadrates of 95; 50g, and 70g and becomes where proper conditions prevail, such as sources where proper conditions prevail, such as your pressure equal to previously and the proper conditions prevail. For 1935, such decorts one occur with some surface temperatures a ligh as 20° . Substains wolders received give rise to stable arranged hydrate occurrences analogous to both the above odoutrances. (Clathrate hydrates, functions, subharing volcium).

